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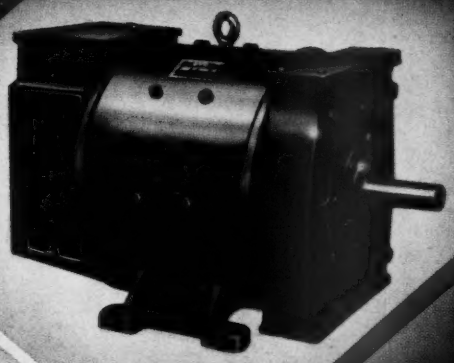

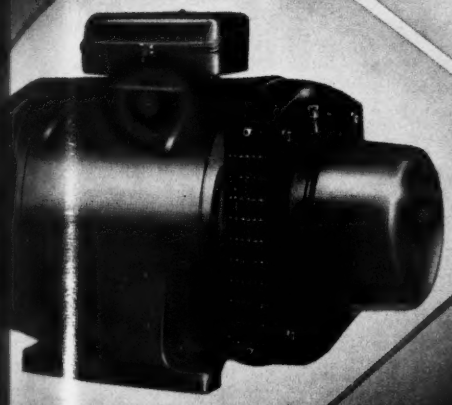

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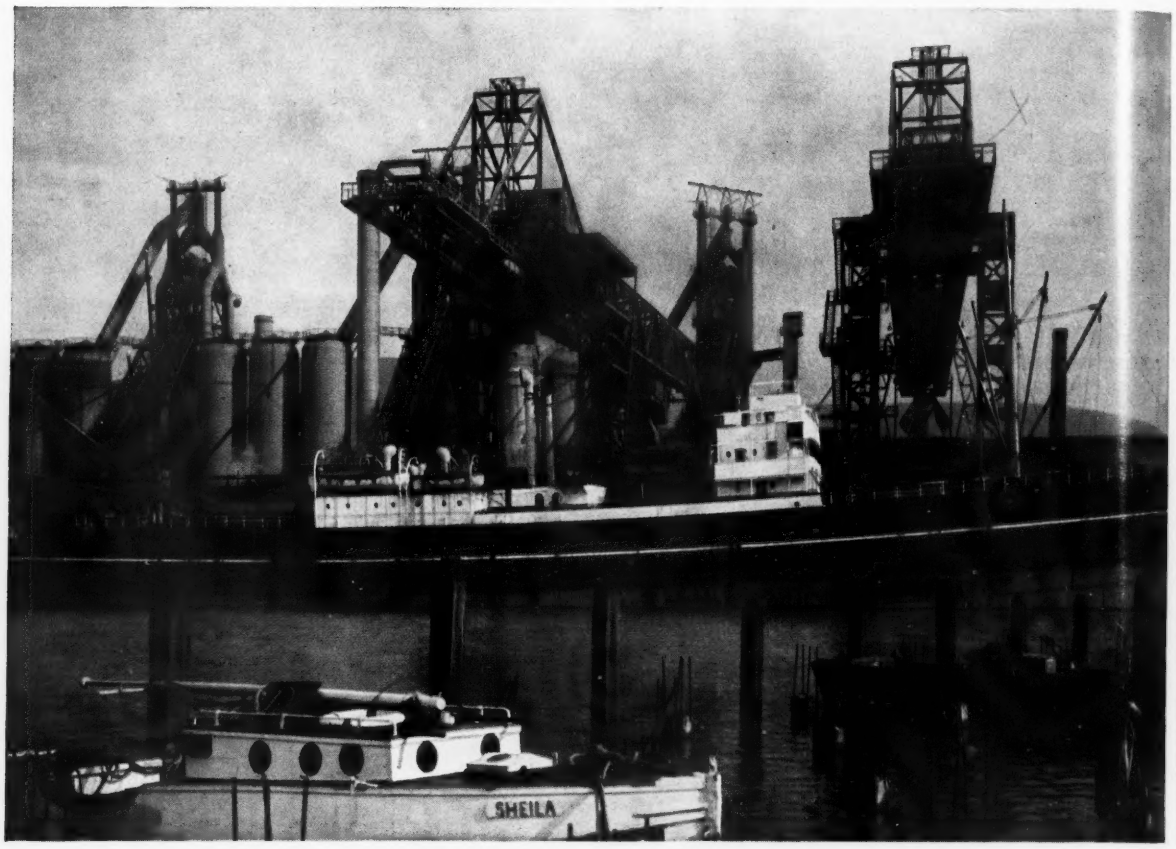

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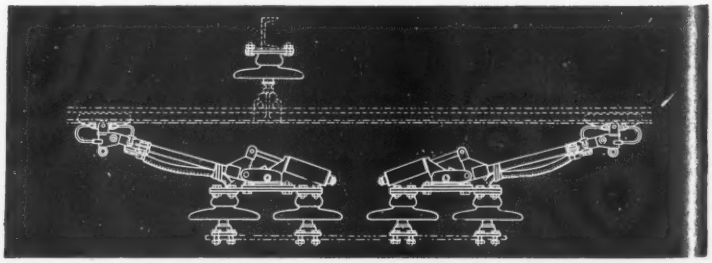

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In This Issue

131 EDUCATION FOR ENGINEERS
133 D.C. DISTRIBUTION
136 CARBON BRUSH BOXES
139 EARTH FAULT LOOP IMPEDANCE
141 ADVANCED ENGINEERING EDUCATION
143 VIEWS ON THE NEWS
144 PERSONAL AND SOCIAL
146 INDUSTRIAL NEWS
148 GENERATION AND DEVELOPMENT
149 FINANCIAL SECTION
151 PROGRESS IN MANUFACTURE
153 ELECTRIC FENCE CONTROLLERS
157 NEWLY DEVELOPED GATE-END BOX
158 DOMESTIC SURVEY — ELECTRIC IRONS
163 ENGINEERING IN EUROPE
165 NEW ELECTRICAL EQUIPMENT
166 NEW PATENTS
167 NEXT WEEK'S EVENTS
168 CONTRACT INFORMATION

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103 *REGIONAL GUIDE TO ELECTRICAL CONTRACTORS*
107 *CLASSIFIED ADVERTISEMENTS*

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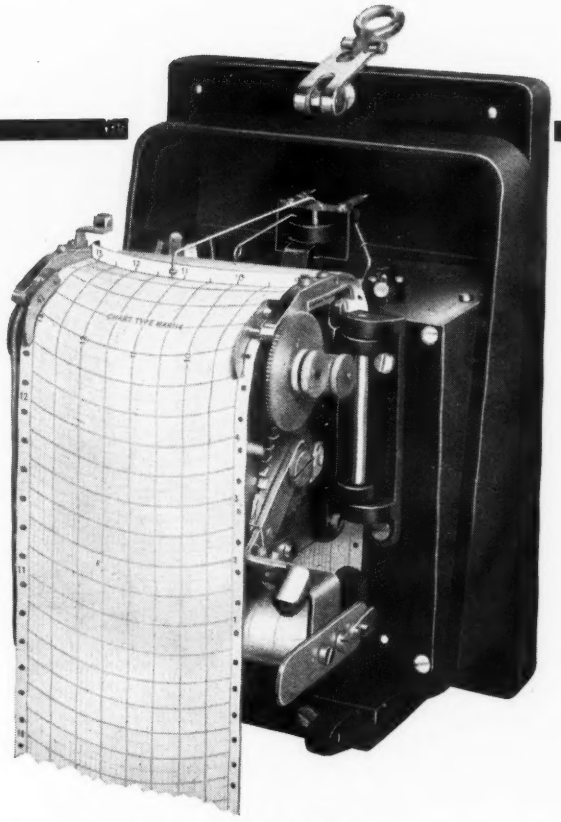

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ELECTRICAL REVIEW

27 January 1956 Vol. 158 No. 4 Established 1872

Education for Engineers

THE three papers presented recently to a joint meeting of the Institutions of Civil, Mechanical and Electrical Engineers under the broad title of "Advanced Courses for Engineers in Industry" by Mr. H. D. Morgan, Professor G. F. Mucklow and Dr. Willis Jackson (reported in our last issue) give us another welcome opportunity to comment again on this vital subject; welcome and vital, we stress, because of the worsening situation in regard to the supply of technologists in this country.

All three of the papers appear to call for a wider education than that of mind storage of technical data and the means of calculating such data. We rejoice in this because nothing is more important to the progress of engineering than that its personnel, particularly the upper strata, should be able to make the widest possible use of the technical information it possesses.

We do not wish to enter into any controversy about the definitions of any of the classes of engineers, but inasmuch as it supports the above views we should like to quote an extract from the definition of the term "professional engineer" which has been accepted by the Conference of Representatives from the Engineering Societies of Western Europe and the U.S.A. (EUSEC) and the Commonwealth Engineering Conference for purposes of discussion: "A professional engineer is competent by virtue of his fundamental education and training to apply the scientific method and outlook to the analysis and solution of engineering problems. . . . His work is predominantly intellectual and varied. . . . His education will have been such as to make him capable of closely and continuously following progress in his branch of engineering science . . . and such that he will have acquired a broad and general appreciation of the engineering sciences as well as a thorough insight into the special features of his own branch."

All this points to university education which, coupled with experience, offers the broadest education of all. The first requirement, of course, is the right type of brain to receive such breadth of education, and the mind so equipped will thus gain an ability to envisage the results of great schemes before the details are worked out; that is true engineering.

But what of the preparation for this advanced work, for industry has now become aware of the fact that in the early stages lies the real failure to produce the technologists so sorely needed by this country if it is to maintain its high standard of living? Since we first called attention to "A National Emergency" in the *Electrical Review* of 3rd September, 1954, a good deal has been done to remedy the deficiencies in this preparatory work, such as the issue of the I.E.E. film and booklet to encourage the school leaver to join the industry, and the raising of school teachers' salaries. Only in such ways is it possible to avert the serious crisis which seems to be upon us because there are insufficient technicians and technologists to provide for our needs.

THE CULTURED ENGINEER

With the discussion now current on the need to drastically expand our numbers of technologists and technicians if we are to keep abreast of Russia and the United States in this respect, there is a persistent demand for a more balanced product from schools and universities. A leading article in the *Daily Telegraph* last week expressed it as " Whole Men or Half Men? " While not disputing that an insight into humanistic thought is invaluable as an adjunct to a specialized technical or scientific education, which may commence on entry to the sixth form at 16 or 17, we feel strongly that the implied assumption of an inevitable narrowness of mind in present-day technologists is not always warranted. Continued contact with engineers of all ages convinces us that they, at least, have no less a love and appreciation of the arts than members of any other group in the community who have entered upon their life's work through the universities. Those who can become brilliant scientists and at the same time gifted humanists are few in any generation; and to inculcate the basis of a scientific education under modern conditions is a major task in itself, but a careful grounding in the exercise of all mental activities can form the base on which an individual may build throughout a lifetime.

CAUSES OF FIRE

Though evidence of the origin of a fire in a building is often destroyed by the event the particulars given in Mr. L. Gosland's I.E.E. paper (summarized in this issue) are enough to indicate several important tendencies. Apart from a general linear relationship between failure of an installation and its age, no single cause of fire, with one exception, predominates. That exception is provided by chance contact between wiring or earth-continuity conductors and composition gas pipes—a hazard that is likely to diminish in time. The paper makes a good beginning to investigations now in hand by E.R.A. Their importance may be gauged from the attribution to electrical causes by the fire services of 10 per cent of fire calls. Further information would be desirable about the type of wiring or fittings involved in proportion to their use, the beneficial effect of change-over from d.c. to a.c. supplies, and the extent to which the position is affected by persistent leakage to earth of currents too small to blow the heavier fuses now required owing to the heavier loading of circuits.

ROLLING MILL DRIVES

In a paper " The Modern Manufacture of Steel Plate for Shipbuilding " presented to the North-East Coast Institution of Engineers and Shipbuilders in Newcastle-upon-Tyne on 13th January, the author, Mr. T. F. Pearson, M.Sc., said in respect of rolling mill drives, that modern drives were without exception electric, and might be twin, particularly for large primary mills, i.e., one motor for each roll consisting of powerful direct-current motors (for variable speed), the larger ones being capable of developing 4,000 to 5,000 h.p., and taking peak loads equivalent to 12,000 horsepower. The reason for the adoption of a twin drive lay in the fact that, for power requirements exceeding about 7,000 h.p., serious design problems arose in connection with pinions for gearing purposes. An advantage of the twin drive was a lower inertia than a single motor drive of the same power. These motors ran at relatively slow speeds, namely, 40 to 120 r.p.m., and the use of the Ward-Leonard control system was universal. In these conditions the motor exerted a constant torque and it could be accelerated and decelerated very smoothly and rapidly, reversal itself in modern installations taking only the fraction of a second for armatures weighing many tons. We would like to add how very much the precise operation and smooth working consequent on the electrical driving must contribute to the quality of the product—steel.

COOLANTS FOR REACTORS

As a means of transferring heat from a nuclear reactor to the steam generating system of a full-scale power station, certain liquid metals possess theoretical advantages over carbon dioxide gas, which is at present the most practicable medium. Further knowledge of the behaviour of such metals under working conditions is required, including their corrosive effects on steel and reactions with water. The most promising of them appear to be sodium and sodium-potassium alloy, which formed the subject of a paper presented by Messrs. W. B. Hall and T. I. M. Crofts (United Kingdom Atomic Energy Authority) before the Institution of Mechanical Engineers. The investigations by the authors over the past three years make a valuable contribution to the solution of outstanding problems and have no doubt afforded much useful experience in the handling of liquid metals.

SHOP-WINDOW LIGHTING

Once again a correspondent to the *Daily Telegraph* has raised the question of shop-window lighting after business hours which he characterizes as " wasteful extravagance." This question was a prominent one just after the war; in fact even shop-window lighting at all was deprecated by some people. Mr. Bernard Moss adequately replies to this querulous correspondent when he speaks of the great " psychological " value of this illumination in creating " an atmosphere of warmth, colour and cheerfulness." He also disposes of the " extravagance " charge by pointing out that the amount of coal involved is negligible and that there is no question of generating plant shortage now. Of course even when generating capacity was low the latter consideration was not of much validity. The puritanism which prompts such outbursts might be better devoted to the pursuit of really necessary reforms not to the deprivation of the public of something which gives pleasure and " uplift."

Owing to the dispute in the printing trade this issue has had to be reduced in size and copies may be late in reaching readers. To all who are inconvenienced in any way, we offer our sincere regrets in circumstances beyond our control.

D.C. Distribution

Present-day Problems in Maintaining Supply

By W. L. Ord*

TOWARDS the centre of one large city the present area covered by d.c. supply is very much the same as it was some thirty years ago, but the demand has changed considerably. Where the demand was of the order of 30,000 kW, it is now about 3,000 kW. The number of rotary substations has been reduced and plant has been taken out of commission, leaving only the minimum required to deal with the load.

The same area now contains some 50 a.c. substations, each of from 500 to 4,500 kVA capacity, which supply the a.c. load, and one can visualize that the d.c. network which was formerly dense and well equipped with substations, feeding points, and interconnecting facilities, is but a shadow of the original with long lean distributors barely able to maintain voltage. Fig. 1 shows the central d.c. network referred to in an area about two miles square. It is a composite diagram of the present-day d.c. network and the nineteen rotary substations and balancing stations which were required in 1925. To-day only four, the Dickenson Street, Oldham Road, L.M.S. and Polygon substations, are in commission and the illustration serves to emphasize the stringing out of the distributors.

Construction of D.C. Networks

Several problems arise in operating a network of this nature. For instance, voltage drop troubles occur; fault location is difficult, especially where a long ring feed has to be broken, thereby creating an excessive voltage drop, even though it be only as a temporary measure; open ring distributors become open ended; feeder cables, if conveniently situated, are transferred to trolley-bus supplies.

The diminishing character of d.c. systems, coupled with the lack of publicity which they receive nowadays, is regarded as responsible for a lukewarm interest shown by distribution engineers generally, yet it is probably true to say that in towns and cities where d.c. still exists the systems are larger in area and loading than any single a.c. l.v. network system.

Usually they are interlaced with two or more a.c. systems, and the problems which arise are more of a financial than a technical nature because one is loath to spend capital on d.c. reinforcement for new supplies on the one hand, and the high cost of change-over on the other.

It is this latter fact—the high cost of change-over enforcing a slow pace in eliminating d.c. systems—that has prolonged the life of the networks, and as the pace of change-over is not likely to quicken to any appreciable extent in the next year or so it may be of interest to describe some aspects of the modern operation of a d.c. system.

The usual construction of a d.c. system is of three-wire mains supplied direct from a d.c. source at from 400 to 460 V between the positive and negative outer wires, while the mid-wire is supplied from balancing machines external to, or from additional coils embodied in, the main generator. The balancers are cross-connected between and are excited from the outers, and form a neutral point by way of which any positive or negative current required to restore balance to the system is supplied (Fig. 2).

The mid-point or neutral point is earthed at the substation through a resistance of the order of 1 to 5 ohms in order to limit earth fault current to a maximum of 200 A, and for normal running a circuit-breaker, set to operate at 50 A, is paralleled with the resistance. A recording ammeter with centre zero is connected in the earth circuit to record the polarity as well as the value of the current flowing to earth from either of the outers. Fig. 3 shows a neutral earthing panel arrangement designed for use with normal and hospital busbars.

Feeders

The three-wire distributors are usually supplied by feeders of comparatively heavy cross-section copper which inject at suitably chosen points having regard to current capacity and voltage drop. This is unlike an a.c. network where the distributors emerge from a substation and commence to supply load immediately. The feeders may be three-wire cables supplying three-wire current or they may be two-wire supplying the outers only, in which case the balancing feeder wire is connected to the distributor mid-wire at a convenient point. It is customary to supply a section of the network in which the distributors are interconnected, by means of two, three or four feeders in parallel, when at least two balancer feeder wires are employed depending on local conditions. In the event of a fault occurring a three-wire feeder can be isolated with a section of the distributors, but where two-wire feeders are used care must be taken to ensure that a balancer feeder wire is included in the isolated section.

It is considered true to say that with the above construc-

* Mr. Ord is Central District engineer with the North Western Electricity Board, Manchester.

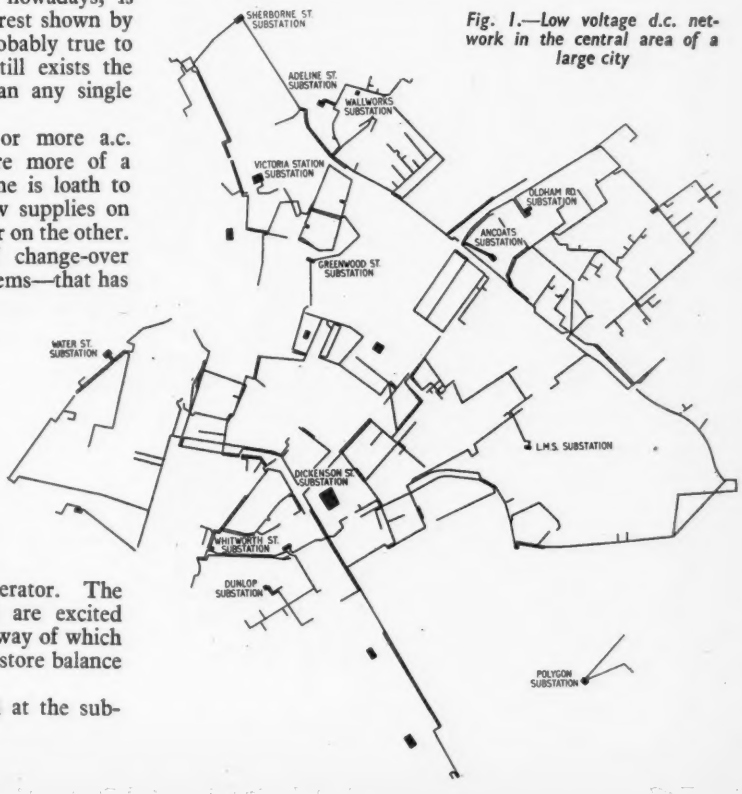


Fig. 1.—Low voltage d.c. network in the central area of a large city

tion one has no abnormal troubles compared with a.c. systems, and more especially so if there are two or more sources of supply operating in parallel.

Planning has become a household word with distribution engineers, but it is chiefly associated with new substations, new mains and reinforcements for a.c. systems, whereas the planning associated with d.c. systems is completely the reverse. Where a.c. networks are superimposed on d.c. networks the latter are very much affected in that progress demands that they shall be eliminated as quickly as possible, yet finance decrees that such elimination shall proceed slowly. Consequently the modern d.c. network is subjected to two powerful forces which can distort it and make it almost unwieldy, yet it must be maintained and operated to serve within the same statutory limits as a carefully planned modern a.c. network.

Very early d.c. networks were largely composed of vulcanized bitumen single cables, which owing to deterioration were gradually replaced by four-core paper insulated cables with a view to eventual change-over, with the load balanced accordingly on alternate cables operating with two positive cores and two negative cores. The feeders remained either two-wire or three-wire by laying four-core cables and bunching the cores as required. Later d.c. networks were built up with three-core paper insulated cables and while the change-over problems of these networks are well known there is little or no trouble in d.c. operation.

The modern d.c. networks, therefore, can be said to fall roughly into two categories, the predominantly three-core, three-wire, and the predominantly four-core, three-wire.

Operation

Change-over of the predominantly three-core d.c. systems is usually dealt with in convenient areas or blocks, whatever system of a.c. supply is employed.

If entire networks are not contemplated in a single change-over then the portion which is considered comprises a deliberately planned scheme. It follows that the portion which has not been considered for change-over becomes a deliberately planned remainder, complete in itself with supply source, feeders, balancers and distributors. Even so, the reduced network will not be so pliable and flexible as it was formerly; some feeders and interconnecting points will have been lost, and some through mains will have become open ended. Thus a group of consumers, for whom there was formerly an alternative means of supply, may now be dependent upon the good behaviour of an open-ended distributor. While this in the main does not and should not worry the consumers, the maintenance engineer records automatically that he will have another problem to face in the event of breakdown to speedily effect restoration of supply.

In general it can be said that this type of d.c. network remains 100 per cent d.c. with no superimposing of a.c., and is gradually whittled away section by section in an orderly fashion until all is changed over.

The predominantly four-core cable d.c. system poses many problems in maintenance and operation on account of the a.c. systems superimposed upon it claiming the four-wire cables for a.c. distribution. It is, of course, laid out primarily for a.c. but is supplied and operated on d.c. in the same way as a three-core cable system.

The need for change-over, however, can occur in a number of ways and does not always depend on geographical positions. Perhaps the mains engineer requires to use an existing four-core d.c. distributor for a.c. reinforcement or perhaps the commercial engineer has received an application for a.c. supply, or it may be that a d.c. substation has become uneconomical to operate.

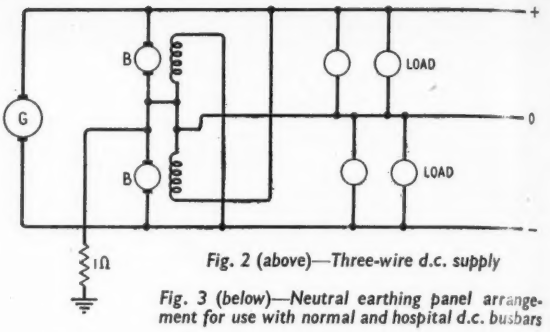
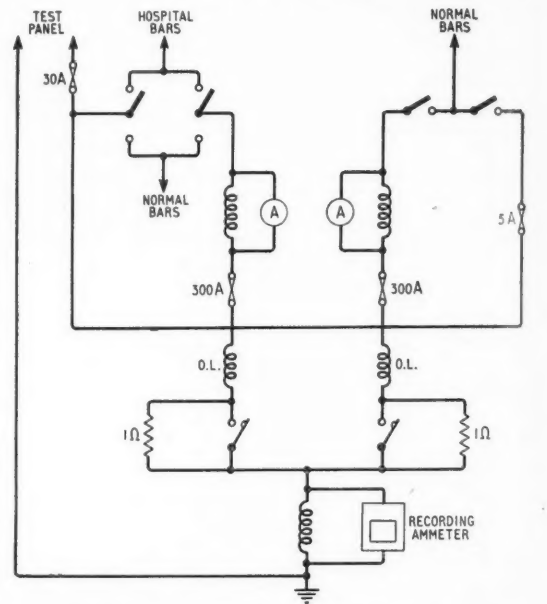


Fig. 2 (above)—Three-wire d.c. supply

Fig. 3 (below)—Neutral earthing panel arrangement for use with normal and hospital d.c. busbars



Whatever the cause, change-over on this type of network almost invariably means a worsening of the remaining d.c. network and often one has to resort to temporary measures to supply consumers who for various reasons cannot be changed over at the same time as their neighbours.

In areas where a.c. and d.c. systems are in operation simultaneously it is sometimes necessary for the cables are laid side by side, and it is not uncommon for one building receiving a.c. supply to be adjacent to another building receiving d.c. Similarly many consumers receive both supplies and internal change-over takes place gradually, perhaps over a number of years.

The average industrial consumer is concerned with output, and while this continues to be satisfactory with d.c. operated machines he is not worried unduly whether they are changed over or not until some specific reason causes the change to be desirable. The commercial consumer also carries on with his d.c. supply and does not press for change-over unless there arises some specific reason for it.

In contrast to these, however, the domestic d.c. consumer is keen to be changed over as soon as possible because so much domestic equipment and apparatus is manufactured for a.c. supply only. He is limited in the use he can make of his electricity service, consequently change-over becomes increasingly a matter of urgency. There is also the domestic consumer who moves his home from an a.c. supply area to a d.c., which can be most inconvenient for him unless he has made inquiries beforehand and is aware of the position.

It occurs often that one consumer in a street or road, or even one consumer sharing a building with others, cannot be changed over on account of long delivery of special apparatus. This is most inconvenient for all concerned, for either change-over must be delayed or a temporary d.c. supply must be made available.

Spasmodic change-over of this kind is apt to leave a most ungainly d.c. network with long straggling cables supplying perhaps only one consumer; duplications and cut mains have to be very carefully recorded in order that they can be operated safely under fault conditions, and also that the final straightening out can be completed without mishap.

Rotary d.c. stations are expensive to operate, and the buildings being usually of fairly large dimensions are considered to be excellent ready-made sites for a.c. transforming stations for both primary and secondary distribution. Extensive modifications are required in the case of a primary station and in order to acquire the necessary space an eye is cast at the d.c. rotary machines together with the distribution board with a view to bringing about their redundancy. Provided there are other existing sources of supply, an investigation of the d.c. load carried will result in at least a partial change-over sufficient to shut down the machines, and transfer of the remainder. A re-siting of the d.c. board in a temporary position will thus provide the necessary space required for the erection of a.c. plant.

The modified d.c. board shortened by removal of machine panels and possibly a feeder or so, is supplied incoming by one or more of the former outgoing feeders, and while this is quite a satisfactory arrangement from a station point of view, the already depleted and straggling d.c. network is likely to produce further voltage drop troubles. If these cannot be overcome by normal voltage regulation methods a reinforcement must be carried out by laying future a.c. cables sooner than required and using them temporarily on the d.c. network.

In the case of modifying an existing d.c. station for secondary a.c. purposes, the above d.c. modifications will apply in principle but perhaps will not be quite so extensive. It may be sufficient to remove one machine only, to make way for one transformer and to erect an a.c. distribution board near to or even alongside the d.c. board if possible, to enable any new four-core d.c. distributors to be taken to the a.c. board in their permanent positions, but supplied temporarily by d.c.

Maintenance

The fault incidence on d.c. systems which employ paper insulated lead covered cable is very low and compares favourably with a.c. systems. Apart from mechanical damage to buried cables the faults are almost wholly confined to overheated contacts and cable end boxes. Damage is usually very severe on account of the prolonged arcing supported by a number of feeders in parallel.

When a very low resistance short circuit occurs between one pole and earth, the initial rush of current invariably causes the breaker of the feeder nearest the fault to operate simultaneously with the earth leakage breaker. The cutting-in of the earth resistance limits the fault current to about 200 A if a 1 ohm resistance is used, and depending on the nature of the short circuit the fault will either burn itself clear, or it will remain solidly on until disconnected.

From a locating point of view one prefers the fault to remain solidly on to enable a speedy location to be made, as a varying fault current can be misleading in dividing up a solid connected d.c. network. There are occasions, however, when the fault burns clear leaving no leakage current and no indication of an open circuit. Generally this type of fault recurs within a few days, but the writer has known several to lie dormant for a number of years, and one or two have never been accounted for despite exhaustive testing and inquiry at consumers' premises.

The replacement of v.b. cables with paper insulated cables rejuvenated the d.c. networks so much that their expected life compares very favourably with that of the rotary plant which supplies them. The demand for a.c. supply by the domestic consumers will probably mean that change-over of the networks supplying them will continue to completion, but in the industrial and commercial areas where there is little support for change-over, it may well be that the d.c. networks will exist for some ten to twenty years. In these cases the installation of rectifiers to replace faulty rotary plant and/or reduce operating costs, provides an attractive alternative to mass change-over when considering the economics of low voltage distribution as a whole, and the restriction on capital available for new supplies.

The writer wishes to acknowledge the co-operation of colleagues and to thank Mr. F. Linley, manager, No. 1 Sub-Area, North Western Electricity Board, for permission to publish this article.

Music Transmission Over Radio Links

MR. R. F. ROUS'S paper on pulse-time modulation terminals for music transmission over radio links was discussed at a meeting of the Radio and Telecommunication Section of the Institution of Electrical Engineers on 11th January. Dr. A. R. A. Randall (B.B.C.) opened the discussion and explained that occasions might arise when it would be very useful to employ an existing s.h.f. television link to transmit ordinary sound programmes, although normally this would not be proposed because of the very wide frequency range absorbed. If the problem were attacked *de novo* the decision might be to improve the radio link rather than adopt pulse-time modulation. When the B.B.C. had contemplated planning their v.h.f. programme transmissions it had been suggested that they might multiplex them so that one transmitter could radiate the three programmes. To some extent the paper answered the question why that had not been done. The frequency band would be excessive, economies in the frequency band would raise problems of non-linearity and intermodulation, and the receivers would have been complex.

Mr. C. W. Earp (Standard Telephones & Cables) suggested that with a p.a.m. f.m. system an equipment might be developed giving an improvement of 10 dB in performance over that described in the paper, and drew attention to the theoretically possible use of "the instantaneous compandor."

Mr. N. E. Head (G.E.C.) contrasted the author's equipment with the system of frequency division multiplex in the form used for multi-channel telephony systems. In a particular system of this form, giving 12 circuits in the frequency band 60-108 kc/s, it was normal practice, he said, to extract two or three telephone circuits and replace them with a music circuit provided in fundamentally the same manner by modulation and the selection of a particular sideband.

Mr. A. P. Carter (B.B.C.) asked whether the author foresaw the possibility of employing the present system with the channel bandwidth modified to carry, for example, a 12-channel telephony group. This should make it possible to off-load telephony traffic on to a television radio circuit in times of emergency or heavy traffic commitments.

Mr. H. Stanesby said that a radio relay system for television must cater for a base bandwidth of at least 3 Mc/s, and this was being used relatively inefficiently if it provided only three music circuits and an engineer's circuit. In the U.S.A., where radio relay was widely practised for both types of transmission, it was common to find 600 to 700 telephone channels taking the place of television.

A number of other short contributions were made to the discussion, to which the author replied.

Carbon Brush Boxes

SUGGESTED AMENDMENTS OF RECOMMENDED TOLERANCES

By A. W. Pelerin*

SINCE the publication in 1922 of B.S. 96, which referred to standard specifications for parallel-sided carbon brushes for d.c. commutator machines, there has always been included a recommended set of limits for brush boxes. The original tolerances for d.c. commutator brushes of normal grades were: Width +0·000 to −0·008in and thickness +0·000 to −0·004in, the size of brush boxes being: width +0·008 to +0·001in and thickness +0·005 to +0·001in, giving clearances between brush and brush box of: width 0·001in minimum to 0·016in maximum; thickness 0·001in minimum to 0·009in maximum.

The later revisions of 1938 and 1954 for all ordinary grades of brushes give tolerances for both d.c. and a.c. brushes as follows:—Width −0·000 to −0·003in and thickness −0·000 to −0·003in, the recommended brush box limits being: width +0·005 to +0·003in and thickness +0·004 to +0·002in, giving clearances between brush and brush box on d.c. machines of width 0·003in minimum to 0·008in maximum; thickness 0·002in minimum to 0·007in maximum.

The a.c. holder limits are as follows, bearing in mind that on slip-rings the " thickness " of the brush is measured tangentially to the ring surface and is usually greater than the width which is the axial measurement of the brush across the width of the ring (Fig. 1): width +0·006 to 0·004in and thickness +0·005 to 0·003in, giving clearances between brush and brush box on a.c. (slip-ring) machines of widths 0·004in minimum to 0·009in maximum; thickness 0·003in minimum to 0·008in maximum.

It will be seen that the original tolerances were arranged in such a way that too tight a fit was possible if a maximum size brush was fitted to a minimum size brush box and sticky brushes were too frequently found if the components were the smallest degree out of square or subject to dusty or dirty conditions. At the other extreme excessive clearance could build up. The tolerances apply irrespective of brush size and cross section.

The later revisions were a step in the right direction, but do not go far enough bearing in mind two primary factors—stable running of the brushes and ease of production. Experience has shown that machines using radially running brushes, if they are of fractional horse-power sizes, need a closer fit between the brush and holder; medium size machines work well with the established clearances and larger machines can function quite satisfactorily with larger clearances. In fact on larger slip-ring brushes it is far more satisfactory to have very much greater clearance between brush and brush box.

Machine makers are therefore asking for, and getting, closer tolerances on small brush holders having a size of up to about $\frac{5}{8}$in by $\frac{3}{8}$in and on larger brush holders over, say, $1\frac{1}{4}$in by $\frac{3}{4}$in cross-section brushes, greater clearance than standard. It is easy to see why this is so, because on the smaller ranges of machines they are almost always running at high speeds and a 0·007in or more possible movement of the brush in the box is relatively far more important than the same clearance on a much larger machine with larger brushes.

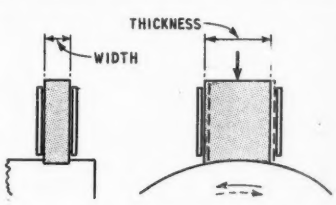


Fig. 1.—Radial brushes relatively thick compared with height (usual on slip-rings)

In general, it is true to say that brushes running on commutators are more sensitive to mechanical instability because of their dual function of current collection and commutation, whereas as a result of the inherent greater stability of slip-ring brushes on a continuous collector surface and better thickness-to-height ratio, far greater clearances can be permitted. This cheapens production by allowing wider manufacturing tolerances and takes care of the greater expansion of the metal graphite type of slip-ring brushes and prevents brushes from sticking on account of accumulations of dust and dirt between brush and brush box.

Assuming for the present that the carbon brush tolerances are reasonable from the brush makers' point of view, and that to work to closer limits even on the midget brushes would be expensive, it is not proposed that any alteration to B.S. 96: 1954 as a standard for carbon brushes shall be made at this time. It is suggested, however, that this standard should be divorced from its non-mandatory recommendation on brush holders. This matter would be better dealt with in some standard specification relating to the mechanical side of rotating electrical machines. It is accepted practice that the allowances for fits shall increase progressively as the dimensions increase and it is felt that the same approach is needed for brushes and holders. This would give wider scope for a clearer understanding of what is involved in the design of brush holders generally.

In the foregoing comments reference has been made only to brushes set radially on the collector. This has been done because there will always be a large number of machines where, either because a reversal of rotation as a

SUGGESTED LIMITS FOR RADIAL OR NON-RADIAL SLIP-RING BRUSH HOLDERS FOR A.C. OR D.C.
(All dimensions in inches)

Brush No. as Indication of Contact Face Area	Limits on Width	Limits on Thickness	Clearance on Standard Brush	
			Width	Thickness
Under 0·234 sq in or S0610 ($\frac{3}{8}\times\frac{5}{8}$) to S0616 ($\frac{3}{8}\times 1$) and 0·5 sq in	+0·004 +0·006	+0·004 +0·006	+0·004 to +0·009	+0·004 to +0·009
Over 0·5 sq in S1014 ($\frac{5}{8}\times\frac{7}{8}$) to S1416 ($\frac{7}{8}\times 1$) and under 1·0 sq in	+0·005 +0·010	+0·005 +0·010	+0·005 to +0·013	+0·005 to +0·013
Over 1·0 sq in S1420 ($\frac{7}{8}\times 1\frac{1}{4}$) to S2416 ($1\frac{1}{8}\times 1$)	+0·007 +0·014	+0·007 +0·014	+0·007 to +0·017	+0·007 to +0·017

* Synthetic Carbon & Engineering Co., Ltd.

Fig. 2.—*Radial brushes relatively thin compared with height*

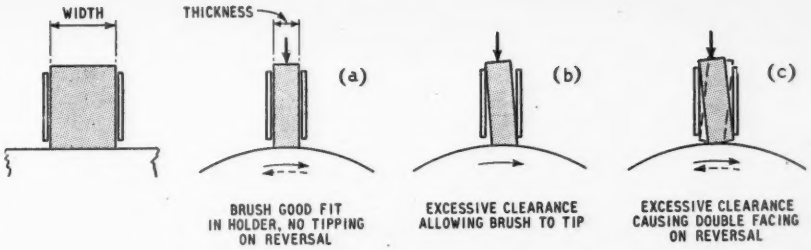


Fig. 3.—*Holder designs where brush is kept to one wall of holder. Wide tolerances can be applied to brush box to give ample clearances*

necessary part of their duty cycle or because the makers send out standard machines which the user may couple up to rotate either way to suit themselves, it is customary to use radial brushes where double facing could occur if the fit was too loose and because such brushes are very liable to instability and chatter with excessive clearances and the fit is vitally important (Fig. 2a, b and c).

In the case of brushes set over to a trailing angle (i.e., tending to follow the direction of rotation, Fig 3b) or brushes running reaction (set over to an angle opposing the direction of rotation, Fig. 3c), if the holder is correctly designed the fit of the brush in the box does not matter provided the limits are arranged so that there is no risk of sticking. Broadly speaking, a brush trailing at an angle of from 8 to 15 deg or reacting at an angle between 30 and 35 deg is maintained in contact with one wall of the brush holder by a combination of the downward and backward thrust of the pressure finger or spring and an upward and backward thrust as the resultant force from the collector.

Under these conditions the two side walls of the brush box only serve to position the brush axially on the collector and the fourth wall could be (and in many cases is) done away with. It will be seen therefore that providing the main thrust wall of the brush box is flat and smooth much unnecessary expense may be incurred in machining the whole brush box to close limits.

There are long and bitter arguments about the relative merits of radial, trailing, reaction, cantilever (Fig. 3a), slide type and grip type brushgear to name but a few debatable points.

As a basis for further discussion it is suggested that brush box tolerances could be as shown in the accompanying tables which have been drawn up after many years of experience in the design of brush gear and embody the combined experience of a very large number of leading firms manufacturing rotating electrical machines.

It should be noted that the limits on brush holders recommended in B.S. 96 are now widely ignored and have been for many years. On the other hand manufacturers of f.h.p. and air-borne machines are trying to get the brush makers to halve the tolerance on brushes and are working to a 0·001 in total tolerance on the brush box.

Many other factors vital to the satisfactory performance of carbon brushes, such as the instability of an overlong brush, the unstable arc of contact of an excessively thick brush, the introduction of tandem brushes and a host of other similar considerations have not been treated here although they are often ignored.

SUGGESTED LIMITS FOR RADIAL AND REACTION OR TRAILING COMMUTATOR BRUSH HOLDERS (INCHES)

RADIAL BRUSH HOLDERS					REACTION OR TRAILING BRUSH HOLDERS				
Brush No. as Indication of Contact Face Area	Limits on Width	Limits on Thickness	Clearance on Standard Brush		Limits on Width	Limits on Thickness	Clearance on Standard Brush		Broad Classification of Brush Group
			Width	Thickness			Width	Thickness	
Under 0·035 sq in C0303 ($\frac{3}{16}\times\frac{3}{16}$) to C1006 ($\frac{6}{8}\times\frac{3}{8}$) C1404 ($\frac{7}{8}\times\frac{1}{4}$) C1405 ($\frac{7}{8}\times\frac{5}{16}$) C2004 ($1\frac{1}{4}\times\frac{1}{4}$) C2005 ($1\frac{1}{4}\times\frac{5}{16}$)	+0·002 +0·004	+0·001 +0·002	0·002 to 0·007	0·001 to 0·005	+0·003 +0·007	+0·003 +0·007	0·003 to 0·010	0·003 to 0·010	Midget and small cross section brushes or "thin" brushes as on a.c. commutators.
C1008 ($\frac{5}{8}\times\frac{1}{2}$) C1009 ($\frac{9}{8}\times\frac{9}{8}$) C1406 ($\frac{7}{8}\times\frac{3}{8}$) to C1414 ($\frac{7}{8}\times\frac{7}{8}$) C2006 ($1\frac{1}{4}\times\frac{3}{8}$) to C2012 ($1\frac{1}{4}\times\frac{3}{4}$) C2406 ($1\frac{1}{2}\times\frac{3}{8}$) to C2412 ($1\frac{1}{2}\times\frac{3}{4}$) C2806 ($1\frac{3}{4}\times\frac{3}{8}$) to C2812 ($1\frac{3}{4}\times\frac{3}{4}$) C3206 ($2\times\frac{3}{8}$) to C3212 ($2\times\frac{3}{4}$) C4006 ($2\frac{1}{2}\times\frac{3}{8}$) to C4012 ($2\frac{1}{2}\times\frac{3}{4}$)	+0·003 +0·005	+0·002 +0·004	0·003 to 0·008	0·002 to 0·007	+0·003 +0·010	+0·003 +0·010	0·003 to 0·013	0·003 to 0·013	Medium industrial type brushes. Traction sizes up to $\frac{3}{4}$in thick.
C2014 ($1\frac{1}{4}\times\frac{7}{8}$) C2016 ($1\frac{1}{4}\times1$) C2414 ($1\frac{1}{2}\times\frac{7}{8}$) C2814 ($1\frac{3}{4}\times\frac{7}{8}$) C3214 ($2\times\frac{7}{8}$) C4014 ($2\frac{1}{2}\times\frac{7}{8}$)	+0·003 +0·007	+0·002 +0·006	0·003 to 0·010	0·002 to 0·009	+0·003 +0·012	+0·003 +0·012	0·003 to 0·015	0·003 to 0·015	Larger brushes over $\frac{3}{4}$in thick.

Multi-Storey Buildings

Electrical Installations in Two "Skyscrapers"

IN a paper presented on 17th January before the Association of Supervising Electrical Engineers at the Royal Institution, Mr. Harry C. MacNary (vice-president, Fischback & Moore, Inc., New York) described, with the aid of numerous lantern slides, the electrical installations in two "sky-scraper" buildings.

The first of these, housing the United Nations secretariat, was a 39-storey structure, in which were two main distribution substations. One, in the basement, contained six transformer banks of three 333 kVA 13·2 kV/208 V delta/star transformers, each bank supplied from a 13·2 kV feeder. The other was on the 28th floor and contained four similar transformers supplied in the same way. The secondaries of all transformers were in parallel to a common busbar through network protectors.

In the basement substation were four and in the upper substation two 4,000 A 208 V take-offs from the secondary busbar. Ten conduits were run from the basement to the 23rd floor; these contained four primary cables (weighing 6·6 lb/ft) and four secondary cables, two conduits being spare.

Secondary distribution boards had each a main electrically operated draw-out 4,000 A circuit-breaker of 100,000 A at 600 V rupturing capacity and subsidiary manually operated breakers. The latter ranged from 600 to 2,500 A, corresponding to the capacity of the busbars forming the distribution system, which was divided into three categories, viz. power, lighting and emergency lighting. The power system was subdivided into two sections, one for the eight escalators and twenty elevators (totalling 1,444 h.p.) and the other for mechanical equipment. Motor-control units consisted of combined circuit-breakers and across-the-line starters.

Average lighting intensity was 50 ft-candles at desk height and one outlet box was installed for every four louvred fluorescent tube fittings. A triple under-floor fibre-duct system at 4ft centres (amounting to 232,000ft for the whole building) was provided for separate 120 V lighting, telephone and miscellaneous low-voltage systems. The central continuously manned fire-control organization was described in detail.

The second installation described was in the Mobil-Secony building of 42 storeys, now under construction. A special feature was the adoption of 460-265 V for distribution instead of the usual 208-120 V now regarded as more suitable where the demand exceeded 2,000 kVA. Short-circuit current on the network of the Consolidated Edison Co. could approach 200,000 A three-phase asymmetrical r.m.s. at 460 V. To secure economy and to permit the use of standard switchgear, 4,000 A reactors were installed at the intake of the four 69 kV and two 13·2 kV feeders brought into the building to six 2,000 kVA transformers.

Thirty-nine elevators having an aggregate h.p. of 2,523 were fed from seven machine rooms. Heating and ventilating and air conditioning motors had a total h.p. of 4,910. Lighting was provided from 460-120 V dry-type transformers of 600 kVA in all. Ratings up to 45 kVA were hung from the ceiling. An average intensity of 50 ft-candles was obtained by the use of 4ft two-tube fluorescent fittings spaced to cover 42 sq ft each.

New Research Reactors

TWO new research reactors are operating at Harwell. They are ZEUS, a name adopted from the initials of its title zero energy uranium system and ZETR (zero energy thermal reactor) and are part of Britain's programme for investigating different types of reactors. ZEUS has been built to check the nuclear calculations on which the design of the fast reactor being built at Dounreay in the North of Scotland depends, and in many essentials it is a full scale model of the Dounreay reactor. A team from the industrial group of the United Kingdom Atomic Energy Authority and the group of Harwell scientists working on ZEUS have combined and are gaining experience in the operation of a fast reactor.

The construction of ZEUS was first announced during the International Conference on the Peaceful Uses of Atomic Energy at Geneva last August. The cylindrical core of the reactor, which is roughly 20 inches in diameter and 20 inches long, is made up of uranium; this uranium is very highly enriched in the rare uranium 235 isotope. Thus in ZEUS uranium is used as a fuel whereas in ZEPHYR, the first fast reactor at Harwell, plutonium is the fuel employed. The core of ZEUS is surrounded by many tons of uranium in which plutonium is formed gradually as the pile runs. The amount of uranium 235 needed to permit the nuclear reaction to start was found to be very close to the predicted value. The enriching of the uranium used in the core was carried out at the Atomic Energy Authority's factory at Capenhurst. The reactor will be operated at a very low power level, only 100 W, so that no cooling is required although the rate of the nuclear reaction will be quite adequate for making all the necessary nuclear measurements. The design power for the Dounreay reactor is about 60 MW.

ZETR uses a nuclear fuel in solution and is intended to provide information about the quantities of fuel which will be required for large scale reactors using such solutions. Plutonium has already been studied in this reactor; uranium 235 is being studied now and uranium 233 is to be studied later this year. Natural water is used as a solvent at present but in the summer heavy water is to be used.

Other reactors operating at Harwell are GLEEP (graphite low energy experimental pile) and BEPO (British experimental pile) in which the fuel is natural uranium rods in graphite; ZEPHYR (zero energy fast reactor) with plutonium as fuel in which it has been shown that two atoms of fissile material can be created for each one burned; and DIMPLE (deuterium moderated pile low energy in which the fuel is contained in heavy water. In addition there are three other reactors under construction. These are DIDO and PLUTO, both powerful research tools in which the fuel is contained in heavy water, and LIDO, a "swimming pool" type of reactor in which the fuel elements are in a tank of ordinary water.

Earth Fault Loop Impedance Testing

An Instrument and Method Developed by the Author

By E. ROSCOE, J.P., M.I.E.E.

IT is rather surprising that the first twelve editions of the I.E.E. Regulations did not contain any mention of the minimum loop impedance test to ensure proper operation of the earth fault protection. The first Acts of Parliament dealing with electricity supply were electric lighting acts, while the first edition of the I.E.E. Regulations published at the date of the first Act (1882) carried the title "Rules and Regulations for the Prevention of Fire Risks arising from Electric Lighting." In the early days of electrical installations fuse ratings were small to protect electric lighting; and at the same time the possibility of earth faults was remote due to the use of wood capping and casing. The necessity for low earth fault loop impedance was, therefore, not so important since the risks from fire and electric shock were kept to a minimum.

With underground armoured cable systems there is normally a good metal path for the fault current to travel back to the source of supply, but in many cases with overhead distribution systems there is no such path and the route of the fault current is often unknown. Unless the phase earth loop impedance or the magnitude of the fault current is measured, the correct operation of the earth fault protection is doubtful.

Section IV. Reg. 406, page 61, " Basic Requirements for Earth ", lays down the value of fault current for any particular fault setting or fuse rating, while Section 5, Regulation 507, page 69, " Test of Effectiveness of Earthing ", stipulates that each completed installation shall be tested by means of an earth fault loop impedance tester of the *current injection type*. The test circuit diagram is shown in Fig. 1, page 70, of the Regulations. In this diagram it will be observed that the loop impedance is tested by using the neutral conductor as a substitute for the phase conductor during testing operations. With due respect, there are a number of assumptions in doing this which are not valid and introduce inaccuracy in test results: —

(1) It is assumed that the neutral conductor is of the same cross section and impedance as the phase conductor.

(2) That except at the supply transformer, the neutral conductor is insulated from earth along the whole length, including all consumers' installations.

(3) That all joints on the neutral conductor such as line clamps have the same resistance as those on the phase conductor.

(4) That there is no voltage drop along the neutral conductor.

A further point is that this method of testing ignores the impedance of the supply transformer.

Under Item (2) there are no ready means of testing with the network alive that the neutral conductor has no connection to earth other than at the supply transformer neutral. Should there be a fortuitous earth connection on the neutral conductor on an installation adjacent to the one under test, the measured loop impedance will be between the two installations, with the path back to the substation in parallel. Should the earth fault loop back to the point of supply be of infinite impedance it would have no effect on the measured loop impedance. The earth electrode of the two installations may be, and often is, the same branch water main and the test current will mainly circulate round the low impedance loop between the two installations. It could be argued, of course, that the fault current will take the route via the waterpipe and the adjacent installation along the neutral back to the source of supply, but the impedance path has not been correctly measured as shown in Fig. 1 in the I.E.E. Regulations.

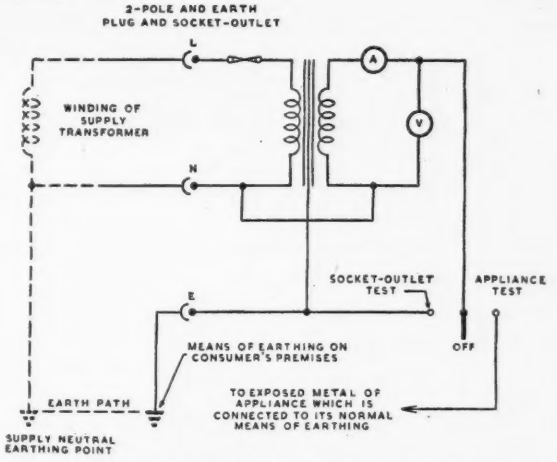


Fig. 1 of the new I.E.E. Regulations—diagram for a method of loop testing using simple test equipment

(3) Experience shows that bad contact on line clamps on the phase conductor may offer a resistance and limit the fault current below that which will operate the protection but will show no apparent difference to a much smaller load current; e.g., a resistance of 4 ohms in a line clamp with a load current of 1·0 A would cause a drop of 4 V on 240 V, or 1·7 per cent, which would pass unnoticed by the consumer. Under fault conditions, however, assuming there was no other loop impedance, this resistance would limit the fault current to 60 A and therefore prevent a 30 A fuse from operating satisfactorily.

(4) The neutral conductor carries the out-of-balance current and the volt drop in this conductor due to this may be in any phase relationship to the test voltage of the test transformer depending on the phase and out-of-balance of the consumer's load. This leads to erroneous values of measured loop impedance since the current circulating during the test is due to the vector sum of the test transformer voltage and the volt drop along the neutral conductor.

Incidentally, measurement of loop impedance using an ohmmeter with internal battery suffers from similar defects. The method of test in the Regulations is confined to current injection. According to the dictionary, this is something thrown in or forced in and precludes all other methods. It may be desirable to show a method of testing, providing that this is sound in practice, but testing by other methods should not be precluded provided they are sound in principle.

The author has designed an instrument which tests the

phase earth loop impedance by applying a fault current of predetermined magnitude which is applied for a limited period of approximately 1/100 to 1/50th of a second using a high speed circuit-breaker (this is covered by a provisional patent). A prototype has been made at the experimental laboratory of the North Western Electricity Board. A series of resistors, the value of which is determined by the current rating of the fuse to be tested, are momentarily connected in turn between phase and earth. The first resistor is a filament lamp which flicks in to prove that the loop impedance is continuous and safe for the test to proceed. A voltage relay is connected across the resistors and operates if a certain predetermined current flows equal at least to twice the current rating of the fuse to be tested. The operation of this relay closes its contacts and lights a neon lamp, indicating that this minimum value of current has actually flowed. Before starting the test a voltage rheostat is set to the actual measured voltage of the supply to ensure the correct voltage across the operating coil of the relay.

If, under testing conditions, a current of at least twice that of the fuse rating flows, then under fault conditions a current at least equal to four times the fuse rating will flow when the test set is not in circuit. The set is simple to operate and in final form it should weigh only 10 to 12 lb. It could therefore be carried by electricians or installation inspectors on public service vehicles.

Metering kVA Demand

IN opening the discussion on the paper "A New Meter for the Kilovolt-Ampere-Demand Charge" delivered to the Institution of Electrical Engineers on 17th January (see *Electrical Review*, 20th January) Mr. D. J. Bolton, M.Sc., M.I.E.E., described the question of how to charge for bad power factor as one of the great insoluble mysteries of electricity supply. He pointed out that the Electricity Boards had no fewer than five different ways of dealing with the problem. The picture was therefore complex, but at least the method suggested by the author constituted the biggest single group, and to that extent his meter supplied a want. Leaving aside the factual position, the actual tariffs, the theoretical basis for the use of this type of meter did not present so strong a case.

The Area Board, besides being an authority in its own right, acted as a kind of tax-collector for another more mysterious body over whose spending it had no control. Only part of the costs collected were affected by power factor and the chief merit of the kVA tariff was that it might induce the consumer to correct bad power factor at the spot where it occurred. Mr. Baxter had taken a step forward, as compared with the Merz method, by using volt-amperes rather than watts. He was to be congratulated on his ingenuity in solving a problem that had puzzled many meter engineers.

Mr. J. W. Carter, A.M.I.E.E. (meter engineer, Midlands Electricity Board) said that it might have been a deterrent to the kVA charge being generally adopted, when the various Boards formed their tariffs, that there was no kVA meter available at a reasonable price that could be used for both large consumers and the less large consumers. Nevertheless, he thought all Boards had an eye to kVA, so the goal was the same though the means might be different. Shortly after the reorganization of tariffs, there was a change in many sub-areas from kilowatt demand to kVA demand metering, or *vice versa*. Those who had had practical experience of both preferred the kVA measurement, in general, he thought, because of its greater simplicity in that the meter readings used to implement the tariff could be checked by the consumer and were directly related to the figures in his account. Power factor, on the other hand, was naturally somewhat indefinite. It was obtained by a calculation that must be obscure to most consumers and was not desirable, for that reason, as a feature in a commercial transaction.

Mr. C. Ryder, M.I.E.E. (Metropolitan-Vickers Electrical Co.) welcomed the paper, saying that there was nothing startlingly complex and the ingenuity lay in the circuitry and the use of more or less well-known components. Metal rectifiers were no longer viewed with suspicion but were now accepted as reliable. The author's device would seem to lend itself admirably to the summation of two or even three circuits by means of two or three meter elements with the discs coupled together. It would also, he thought, lend itself to electrical summation where the current of the circuits could be fed through the rectifiers on to the common primary winding of the transductor. The meter could then be extended to almost any number of circuits.

Problem for Economists

Mr. F. G. Talbot, A.M.I.E.E. (Eastern Electricity Board) pointed out that in the twenty-seven years since E. W. Hill read his classical paper on the metering of kVA and pointed out the anomalies and ambiguities that could arise from the indiscriminate use of the different definitions of kVA very little progress had been made towards solving this fundamental problem. He seemed to remember that the statement was made that the usual practice, at least in those days, was first to select the instrument, then determine its characteristics and then frame the tariff. His main object in speaking, he said, was to put in a plea for a solution to the problem which lay, he thought, with economists and tariff builders. In the absence of a solution a good deal of money would continue to be spent for no good reason.

Mr. A. R. Mowl (English Electric Co., Ltd.) observed that no indication was given of any device for smoothing the a.c. rectified current which was fed to the wattmeter. He thought this might mean that the a.c. fed to the wattmeter would produce a torque of its own which might be an error term in the indication. In view of this, it seemed rather bold to say that the degree of accuracy normally associated with precision wattmeters was obtained from the device. He suggested that tests should be made to determine the effect of small changes in the load phase-angle. Such variations might be unimportant in operation as they would cancel out, but they might be important in the test room.

Mr. S. F. Knight (Ferranti) drew attention to the statement that the magnetizing current of the transductor or the current which would pass at low load was about 1 per cent of the full load current. At low loads this would seem to be embarrassing. It might perhaps be overcome by means of a bridge circuit. That would involve the voltage transformer being centre-tapped, and the transductor magnetizing current would be balanced against the magnetizing current of a small choke. This would do away with the necessity for the anti-creep holes and make for a more reliable type of design.

Mr. H. S. Petch (London Electricity Board), who was in the chair, expressed the view that the author had been somewhat unfair to the supply industry in making the use he had made in the paper of this notion of unfairness. But it was quite unfair to pick out a particular aspect of power factor and accuse the industry of being unfair because any electricity tariff must of necessity be to a greater or lesser extent unfair.

Advanced Engineering Education

DISCUSSION AT JOINT MEETING OF INSTITUTIONS

THE following is a report of the discussion which took place at a joint meeting on 16th January in London of the Institutions of Civil, Mechanical and Electrical Engineers on the three papers presented by Mr. H. D. Morgan, M.I.C.E., Professor G. F. Mucklow, M.I.Mech.E., and Dr. Willis Jackson, M.I.E.E., under the general title of "Advanced Courses for Engineers in Industry." The papers were reported in our last issue.

Mr. G. S. C. Lucas, O.B.E., M.I.E.E., suggested that Professor Mucklow's statement in respect of continued engineering education and training that "except insofar as short term aspects were concerned, engineering firms in general remained as yet unconvinced of the existence of the problem and still less of its urgency" was a little unfair. It would have been fairer to say that the formula for successful collaboration had yet to be worked out. As to the suggestion that the best form of collaboration between universities, technical colleges and industry was for industry to send back to universities men who had already had several years of industrial experience, in addition, of course, to two years' practical training and two years' National Service, quite obviously if they could be spared to return to the universities for one or two years they might learn much, but it was questionable whether the amount they would learn would justify that prolonged absence. Similarly, if young men of the same age and ability who had chosen an academic career could be spared from the universities for one or two years in industry, they would learn much, especially those who had never been in industry.

Apart from the difficulty of releasing students for such courses, proposals for collaboration must take into account the fact that much of the specialized knowledge that should be included in advanced courses was in industry. There was a great deal in the larger firms and smaller pockets elsewhere, and the whole needed to be integrated into courses with the universities' contribution.

Length of Training

Professor S. J. Davies, D.Sc.(Eng.), Ph.D., M.I.Mech.E., said that as a nation we had long been too complacent and too satisfied with the three academic years amounting to about 90 weeks in which to give engineers the fundamental side of their training. Competitors had all allowed a much longer period, and to meet the demands of modern developments it was necessary to supplement that short period for a proportion of the graduates. His view was that the present system should be adhered to and supplemented as necessary with advanced courses, since experience had shown that they were more effective when given to men with considerable practical experience.

With regard to Professor Willis Jackson's description of staff courses and the working of syndicates, the speaker thought too much emphasis was placed, both in undergraduate and in advanced courses, on an active delivery of instruction by lecturers and a more or less passive reception of it by their pupils. Further, the ability of advanced pupils to contribute mutually to a study and the interplay of ideas between the members of a group were rarely sufficiently exploited. The syndicate system went a long way to correct that.

Mr. R. G. Bellamy, O.B.E., M.I.Mech.E., said that there was a greater awareness of what was going on in technical colleges than in universities. He felt that universities were like barristers and doctors in that they hesitated to advertise their wares. It was significant that in his industry twelve adult scholarships were given a year and never once had there been an application to take a course in a post-graduate school. The universities must be less shy and come to industry.

Dr. J. E. Richardson, A.M.I.Mech.E., supported Professor Willis Jackson's caution to the effect that the counting of heads and the number of people taking courses did not necessarily mean that they had absorbed what they had heard.

With regard to the Regional Advisory Councils, something of the industries' needs in a district could be learnt, but his experience was that they did not ask for more than about 10 per cent. The professional institutions very rarely made it known what courses were wanted, and industry did not give that information at all. Therefore the colleges made a guess on a somewhat hit and miss basis.

Organization of Courses

Professor E. Bradshaw, M.B.E., said that many courses would be made more effective if more care were taken in the choice and the limitation of the scope of the topic concerned. Secondly, it was necessary to take care in the selection of those attending. That could not be done by a directive as to who should and who would not attend, but effective control could often be gained by making it clear as to what the course was aimed at, what it would contain and what the college would like in the way of qualifications of those attending.

In his view the professional teacher had a big part to play in the organization of courses. Those courses which were organized by the teacher tended on the whole to be more coherent than those left to somebody in industry to organize.

Dr. W. J. Gibbs, M.I.E.E., said that most undergraduates in their studies stored away their learning into clearly defined compartments, but they had no idea of the underlying unity. The situation was even worse when they went into industry and took up design or research, for then they kept the compartments tightly closed and learned to manage without developing those habits of thought and methods of analysis they had learnt. The fact was that it was possible in design and research to manage without advanced theory by combining the basic elements of theory with experience and engineering intuition. Once that intuition was acquired there was little incentive to acquire the much more difficult art of applying advanced theory to practical problems, yet that art was necessary for any real permanent progress.

Mr. M. L. Meyer, B.Sc.(Eng.), A.M.I.Mech.E., suggested that the point of view of the student who had made use of the opportunities offered was missed. His criticism of the relevance of the courses would be of the first importance. Obviously the views of one student alone would not give a representative and comprehensive picture, but the combined views of several students could well form an instructive contribution.

Mr. M. W. Humphrey Davies, M.I.E.E., said that experience had convinced him that there were several ways

in which the universities could contribute and which would be of great benefit to both parties, provided courses could be arranged so that they did not take up too much of the time of the university staff and, at least under present conditions, provided they did not distract people from work in industry.

Mr. Tams said that industry was in fact doing a great deal in the direction of post-graduate courses. His own concern had held no fewer than 25 courses during the last twelve months for men five or ten years beyond their apprenticeship, and as a matter of interest it was found that if some of the work were done in the company's time and some in the man's own time it was a great help.

Mr. J. F. Coales, M.A., M.I.E.E., suggested that the evening and short courses were of much greater value in training experts and specialists than in giving people help to become senior executives. That was largely because it was necessary not only to get over the advanced theory and practice, but also to get over something psychological, the attitude of mind in the application thereof.

Professor F. K. Bannister, Ph.D., A.M.I.Mech.E., said that the difficulties of industry in releasing men for the long-term courses must not be underestimated, but it must also be remembered that such courses were intended only for the very few. The men for whom they were designed comprised only a minute fraction of the graduate population of industry, and there had been encouraging signs over the past two or three years that more firms were prepared to forgo a man's services for nine or even twelve months in the belief that the eventual dividends would amply repay them for their temporary inconvenience. Those acts of faith must at all costs bring forth from the universities the very best that they had to offer.

Mr. P. P. Eckersley posed the question whether, at the present time, endeavours were not being made to make experts first and men afterwards. He suggested that it might be better to make the man first and the expert afterwards. If during the formative years of a man's life he had a broad general education, he was intellectually trained to think of the relationship of the different aspects of technology, science and research, and would be able to handle people.

Fires and Age of Installations

CORRELATION between age of electrical installations and incidence of fires leading to calls to fire brigades was examined by Mr. L. Gosland (Electrical Research Association) in a paper presented on 19th January to the Institution of Electrical Engineers' Utilization Section. The data was supplied by ten Area Boards serving 2·5 million consumers outside London. The Joint Fire Research Organization divided the causes of fires between fixed and flexible wires and cables. The survey covered some 1,100 fires from 1951 to 1953 inclusive. Definite information on the cause of these was obtained in 601 cases, all of which were attributed to defects in the fixed parts of electrical installations.

A direct relationship was indicated between fires due to defects in fixed electrical equipment and its age but there was no clear indication of rapid increase after any specific age. The incidence of fires in installations more than ten years old was approximately proportional to age; the chance that an installation would be subject to fire in a given year was about seven in a million for each year of its age in that year.

Installations of early post-war design had a fire risk greater than might have been expected from previous experience, but at that time new techniques in building construction and installation practice were introduced. An unduly large number of fires then were associated with fuses, fuseboards, distribution boards and control units.

The commonest primary cause of fire was found to be defective wiring and the chief secondary cause was contact between earth-continuity conductors and composition gas pipes, which occurred even when earthing was satisfactory in all respects except that of separation from other services. The question was raised whether bonding might not be more satisfactory than attempts at separation. Otherwise there was no single type of defect the elimination of which would lead to outstanding reduction in the incidence of fires. In 25 per cent of the fires due to leakage in service equipment, the leakage was attributable to moisture.

TABLE 1.
ORIGIN OF FIRES ATTRIBUTED TO ELECTRICAL CAUSES, 1951-1953

Cause	Total	Number without dates
Reported electrical but disputed	57	—
Defects in service equipment	82	27
Defects in fittings	121	22
Defects in wiring	264	23
Loose connections	44	10
Unauthorized wiring, etc.	54	10
Moisture	46	30
Heat	7	1
Defects in appliances	74	13
Earth faults associated with gas	188	18
Earth faults not associated with gas	27	1

TABLE 2. DEFECTS IN SERVICE EQUIPMENT

Type of equipment	Number of fires caused			Total
	1951	1952	1953	
Fuse	6	14	6	26
Service cable	7	5	5	17
Meter	5	3	5	13
Service tee-joint	—	—	2	2
Sealing chamber	3	1	1	5
Service intake (overhead)	1	—	1	2
Service wiring	2	—	9	11
Other	1	1	4	6
Total	25	24	33	82

TABLE 3. DEFECTS IN FITTINGS

Type of fitting	Loose contact	Leakage			Fuse operation	Moisture	Unknown	Total 1951-1953
		To earth	Between lines	Unspecified				
Earth-leakage circuit-breaker	—	—	—	—	—	—	1	1
Splitter	1	—	1	1	—	—	—	3
Switch	4	4	1	—	—	—	4	13
Joint box	—	1	1	1	—	1	4	7
Lighting fitting	1	1	1	—	—	1	5	8
Ceiling rose	1	1	4	—	—	1	1	7
Plug, socket	3	5	2	3	—	—	1	14
Fuse, fuseboard, distribution board, control unit, etc.	17	1	1	6	5	2	19	47

VIEWS on the NEWS

By REFLECTOR

IN the past, from time to time, I have made remarks on consumers' deposits. I believe that some of the Electricity Boards have dispensed with this rather antiquated requirement but others still hold on to past deposits and still ask for this "security" from new consumers. It is laid down in the Electric Lighting (Clauses) Act, 1899, that interest at the rate of 4 per cent per annum is to be paid on deposits. A friend of mine who was asked for a sum of £5 in 1944 sent a note with his payment of a bill in 1950 asking whether he should not be credited with interest on his deposit and, sure enough, the Electricity Board deducted six years' interest from the bill. Since then he has received no further interest and he wonders whether it is the practice of Boards to pay up only when they are reminded of their obligation. He also wonders what happens to the deposits when consumers move away from an area or die. It's an interesting point.

* * *

An advertisement appeared in the *Electrical Review* recently by the Government of the Federation of Rhodesia and Nyasaland, seeking scientific and technical staff for telecommunication work but laying down the condition that employees of the British Post Office could not be considered. This puts publicly a policy not uncommon in private as between large "private" employers in the electrical industry and sometimes between them and nationalized industry. It is a policy that hits hardest not at those near the top, of sufficient standing to move freely where they will, not at those at the foot of the ladder who have yet to acquire specialized skills, but at those in moderately responsible positions, frequently, or so it seems to them, stationary so far as future promotion is concerned. Such discrimination is, I feel, an iniquitous practice. It should not occur privately and most certainly it should not be practised by Government concerns who might be expected to give a lead in these matters. Such a constraint on free movement can result in an artificial and unfair holding down of salary scales and inevitably produces a feeling of frustration and antagonism on the part of those affected, which in the long run can only do more harm than good.

* * *

It is probably a counsel of perfection to suggest that all designers of equipment should have actual experience of the conditions in which it is to be used. So many men are compelled to depart from a line in which they have been brought up into allied, or even quite different, branches that it is too much to expect. When, however, the conditions surrounding their new work are very different from those to which they have been accustomed it is essential that they should be given a chance of studying the subject on the spot. Nowadays the amount of electrical and electronic equipment in ships is becoming ever greater and more complex and it operates in situations vastly different from those ashore although much of it was originally designed for use on land. It is the increasing practice of the Admiralty to give scientists, designers and others concerned with the development of naval equipment opportunities for periods of service afloat, thus providing useful contacts for them with the actual users of the equipment. This applies not only to members of the Royal Naval Scientific Service and specialists from other Government Departments but also to some extent to designers and engineers of industrial firms engaged in Admiralty work.

* * *

British dogs are notoriously allergic to postmen, dustmen and other regular callers at houses and it seems that their American confreres share their aversion. At any rate trouble seems to have been experienced by the meter readers of the Richmond (Virginia) Department of Utilities. The department's "safety co-ordinator" says, according to the *Electrical World* (New York), that until about a year ago dogs were a major hazard to meter readers, although this does not seem to be borne out by the statistics which showed that "dog bites accounted for an average of one lost-time accident a month." One meter reader, however, was found to have a long-period immunity and the department discovered that it was because he always carried in his pocket a box of dog biscuits or candy with which he made friends with vicious dogs on his route. Since the department made sweets standard equipment, it is reported, not a single meter reader has been bitten. The major hazard now, I suppose, is that readers will themselves consume these sops to the local Cerberus (or Cerberuses).

* * *

Much space was devoted in the *Electrical Review* of 29th January, 1886, to proceedings in the United States to test the validity of Alexander Graham Bell's claim to be the inventor of the telephone. Bell had secured American patents on the invention and successfully brought actions against infringers of his rights. These infringers hoped to set up the German Reis or the American Elisha Gray as the true inventors. A long letter from Bell to the United States Attorney-General, A. H. Garland was reproduced. Bell mentioned that a suit had been brought against him, at the instance of one of the infringers, alleging perjury and fraud on his part in the obtaining of his patents. He complained that this action had been brought not in Washington where he lived or in Massachusetts where his company operated but in Tennessee "where I have never been and where the owner of my patent has not even one office or officer." He further alleged that this had been done by Mr. Garland's department and that "the infringer . . . is a corporation of which you were one of the organizers, one of the largest stockholders, director and counsel." The suit was later dismissed but the Government brought a new action in Boston and litigation went on and on but the final decision was in Bell's favour.

PERSONAL AND SOCIAL

News of Men and Women of the Industry

The Minister of Fuel and Power has appointed **Mr. James Bowman,** C.B.E., J.P., to succeed Sir Hubert Houldsworth, Bt., Q.C., as chairman of the National Coal Board when Sir Hubert's term of appointment expires on 31st July next. He has also appointed **Mr. J. Latham,** C.B.E., to succeed Mr. Bowman as deputy chairman of the Board from the same date. Both appointments are for five years.

The Institute of Radio Engineers, New York, has elected **Mr. L. C. Jesty,** B.Sc., M.I.E.E., F.Inst.R.E., F.T.S., F.B.K.S., of Marconi's Wireless Telegraph Co., Ltd., as a Fellow of the Institute. Mr. Jesty is chief of the television research group at the Marconi Research Laboratories, Great Baddow, in which capacity he joined the company in 1949. In recent years he has been closely connected with research into, and evaluation of, colour television systems, and has done much pioneer work on anglicized versions of the N.T.S.C. system, with one of which the B.B.C. is now conducting experimental transmissions.

At a recent annual general meeting of the Association of Manufacturers of Small Switch and Fuse Gear **Mr. R. Nicholls** (Wm. Sanders & Co. (Wednesbury), Ltd.), and **Mr. B. W. Pickup** (Falk, Stadelmann & Co., Ltd.), were re-elected chairman and vice-chairman, respectively, of the Association for 1956.

The appointment of two new executive directors, both of whom joined the company early in their careers, is announced by the Plessey Co., Ltd. The are, **Mr. S. W. Mills,** F.C.W.A., and **Mr. E. H. Twaits.** Mr. Mills, who joined the company in 1932, is manager of the coilwinding division, and Mr. Twaits has for the past three years been manager of the components division. He joined the company as an audit clerk in 1945.

Mr. S. W. Mills

Mr. E. H. Twaits

Mr. A. W. Pelerin, who writes in this issue on "Tolerances and Internal Dimensions of Brush Boxes," received his technical training at the Northampton Polytechnic and served his apprenticeship with the Power Equipment Co., Ltd. He joined the Synthetic Carbon & Engineering Co., Ltd., in 1929, which was then a subsidiary of Ringsdorff Werke A.G., Mehlem/Rhein, and studied carbon brush and brush holder problems here and at the German works. After holding various posts with the company he became manager, and in July, 1953, on the 25th anniversary of the registration of the company, was appointed director. Mr. Pelerin is a member of the Institution of Works Managers, and of the Association of Supervising Electrical Engineers.

Mr. J. D. Markland, M.I.E.E., Assoc.I.Mech.E., has been appointed home sales manager of the Hotpoint Electric Appliance Co., Ltd. Mr. Markland served an indentured engineering apprenticeship with the British Thomson-Houston Co., Ltd., at Rugby and has spent nearly twenty years in the electricity supply industry, having held appointments with the Northampton Electric Light and Power Co., the Westminster Electric Supply Corporation, Ltd., Central London Electricity, Ltd., Maidenhead Corporation, and the Southern Electricity Board. He has served on various committees of E.D.A., and is a member of the Council of the British Refrigeration Association. During the last war he served in the Royal Navy and attained the rank of commander (L) R.N.V.R. Mr. Markland left the supply industry in 1950 to join the refrigeration division of the Pressed Steel Co., Ltd., as home sales manager, which appointment he is now relinquishing.

Mr. J. D. Markland

At the second annual dinner of the **Desoutter "21" Club** which was held recently fifteen new members, who had completed twenty-one years of service with the company on the 31st December last, were presented with gold watches by Mr. G. H. Webb, managing director.

Over forty of the staff of the **Hurseal Group** of heating companies (Hurseal Ltd., Gulf Radiators Ltd., and Sealdraught Ltd.) were the guests of the directors at the annual staff dinner and dance held at the Café Royal on 6th January. After dinner, Mr. A. C. Hazel made a brief speech; dancing and party games followed.

After graduating at Sheffield University in 1943, **Mr. H. Burton,** B.Eng., who writes in this issue on "Electric Fence Controllers," worked for some years on the design and application of radio - frequency dielectric and induction heaters. He was with the British Iron and Steel Research Association for a short period before going to the National Institute for Research in Dairying in 1948. For a time he investigated the alleged lethal effect of radio-frequency voltages on bacteria but has subsequently become interested in general problems connected with dairy research.

Mr. H. Burton

The annual prizegiving to students and apprentices of **Siemens Brothers & Co., Ltd.,** was held at Woolwich Polytechnic on 6th January. In the chair was Dr. G. W. Sutton, director of research and education and the awards were presented by Dr. J. N. Aldington, managing director. Also on the platform were Mr. W. G. Patterson, commercial director, Mr. J. A. Latham, chief accountant, Mr. W. T. Pope, labour manager, Mr. H. E. Helwig, chairman of the governing body of Woolwich Polytechnic and Mr. R. F. Luff, the company's education officer, who was responsible for the arrangements. After presenting the awards, Dr. Aldington addressed the students and apprentices and outlined some of the varied careers available to them in connection with the company's widespread activities. He concluded by

Dr. J. N. Aldington (left) presenting an award to one of the apprentices at the annual prizegiving to students and apprentices of Siemens Brothers & Co., Ltd. Seated on the left is Dr. G. W. Sutton

offering to provide a prize to be awarded in future years to the best student or apprentice of the year. After the prizegiving, refreshments were served in the refectory and gymnasium and the audience then returned to the hall to see two one-act plays presented by the Students' and Apprentices' Association. There was also an exhibition of the work of students and apprentices in the common room.

Mr. A. R. Mitchell, M.B.E., M.C., J.P., and **Mr. E. R. Cameron,** B.Sc., have been appointed directors of Yarrow & Co., Ltd.

OBITUARY

Mr. H. Allcock.—We regret to report that Mr. Harry Allcock, M.I.Mech.E., M.I.E.E., died at his home at Hale, Cheshire, on 21st January at the age of seventy-six. Mr. Allcock was a well-known figure in the electrical industry for over half a century. He had been with W. T. Glover & Co., Ltd., for fifty-five years, for thirty-five as export manager, and previously was the first electrical engineer of the Trafford Power & Light Supply Co. He was an ardent advocate of the use of the decimal system and had been chairman of the Decimal Association; he gave evidence before the Royal Commission on Decimal Coinage which reported in 1920. Mr. Allcock had also been a vice-president of the Federation of British Industries and of the British Engineers' Association and an active member of the Manchester Chamber of Commerce.

USKMOUTH EXPLOSION

We have received from Mr. H. J. Bennett, divisional controller, South Wales Division, Central Electricity Authority, the following statement relating to the explosion which occurred at the Uskmouth power station recently:—"At approximately 10.30 a.m. on 18th January No. 5 turbo-alternator was carrying its normal load when according to employees who were on duty at the time there was a loud explosion followed by fire in the alternator windings. Examination showed that both the l.p. turbine section and the alternator were damaged beyond repair. The l.p. turbine section was completely wrecked and pieces of the casting and the l.p. spindle were scattered in all directions, causing considerable damage to the turbine itself. Two people were fatally injured, one the turbine driver on the machine at the time of the accident, and the other a contractor's employee. Several other men received minor injuries, but at the present time only two have been detained in hospital. Investigations are now in hand to determine the cause or causes leading to the breakdown of the machine and no doubt in the near future some preliminary report will be issued."

Housing Managers' Conference

Speaking to housing managers of local authorities in the Northmet Sub-Area at a conference in Southgate last week, Mr. C. T. Melling, chairman of the Eastern Electricity Board, said that while Boards must ensure that there was an adequate supply of electricity to meet the needs of consumers, it was well known that the standard of wiring in many pre-war houses was less than that demanded by the apparatus now available to the domestic user.

The problem was how to supply electricity to housing estates without requiring a large capital contribution towards the cost of that supply; the solution found by the Eastern Board had been to ask local authorities to install a certain minimum standard of wiring in their houses so that the tenants would have the opportunity of using electricity to a reasonable degree. It was a policy which meant some commercial risk for the Board, Mr. Melling said, but it had been in operation for several years and discussions had been taking place with a view to the adoption of a similar policy for the whole country.

The appliances which were available to the domestic consumer must be appropriate for the purpose for which they were used and the Eastern Board only sold apparatus which had been tested and proved both for safety and for the suitability to do the job for which it was required. Manufacturers submitted apparatus to the Board's testing house where it was tested thoroughly and only offered for sale to the public when all the requirements had been satisfied.

Mr. F. Boysen, the engineer in charge of the Eastern Board's testing house, said that while apparatus was tested by instruments, many of them specially designed for the purpose, it was also tested by actual use by senior housecraft advisers. The Board also tested appliances selected from the stocks in service centres in order to ensure that the original standard was being maintained. From vesting day to the end of 1955, over 2,000 appliances were examined and about 1,500 were approved; 330 were not approved altogether and 450 were referred back to the manufacturers.

A representative selection of domestic apparatus was on view and many appliances were demonstrated by the senior housecraft adviser of the sub-area, Miss E. M. Yetton. Mr. C. C. Hill, the sub-area manager, presided.

I.E.E. Summer Meeting

As was announced in our last issue, the Summer Meeting of the Institution of Electrical Engineers is to take place in the Midlands from Monday, 25th June to Friday, 29th June. The programme provides many interesting visits and social occasions. On the Monday there will be a civic reception by the Lord Mayor of Birmingham. Visits have been arranged for the Tuesday to the works of the English Electric Co., Ltd., at Stafford; the Wedgwood Potteries; the Lotus Shoe Factory; and the G.P.O. Training College at Duncan Hall; there will also be a tour through Shropshire and Worcestershire. In the evening there will be an informal dinner at Malvern arranged by the English Electric Co., Ltd.

On the Wednesday there will be visits to the B.T.H. works at Rugby, Courtaulds works at Coventry, the G.P.O. transmitting station at Rugby and the G.E.C. works at Coventry. There will also be visits to Warwick and Kenilworth. In the evening there will be a visit to the Stratford Memorial Theatre.

On the Thursday, there will be visits to the G.E.C. works at Witton, to the store of Marshall and Snelgrove, the Science Museum and Art Gallery, the B.B.C. sound and television studios and the works of Restalls, Ltd., and Cadbury Brothers, Ltd. In the evening there will be a dinner and dance in Birmingham. Friday's programme includes visits to the Hams Hall generating station, Lichfield Cathedral, the works of Fisher and Ludlow, Ltd., Birmingham University, the works of Steatite and Porcelain Products, Ltd., at Stourport, and the Electric Construction Co.'s works at Wolverhampton, Carpet Trades, Ltd., at Kidderminster, and the Stewart Crystal Glass Works at Stourbridge. An informal gathering on the Friday evening will take place at the Botanical Gardens, Birmingham.

Overseas Trade in December

Exports of electrical machinery, apparatus and appliances from this country during December had a value of £17,131,485, as compared with £17,228,099 in December, 1954. The year's total of £191,879,393 showed a considerable increase over the 1954 figure of £170,164,550. In the electrical machinery and heavy apparatus class, exports in December at £4,971,808 were £647,777 less than in December, 1954, but the total for the year of £60,733,473 showed an increase of £3,163,966 over 1954. Details of the trade in December and for the twelve months will appear in our next issue.

INDUSTRIAL NEWS

British Electrical Power Convention

Since we published the programme for the British Electrical Power Convention at Torquay in our last issue we have received a note of a re-arrangement of some of the papers. The order of reading will now be as follows:—

Friday, 25th May.—10 a.m. (1) "Electricity in Rail Transportation" by Mr. S. B. Warder; (2) "Electricity Supply and the Railway Load" by Messrs. F. J. Lane and W. B. Noddings. 2.30 p.m. (3) "The Electric Locomotive and the Diesel-Electric Locomotive" by Mr. C. M. Cock; (4) "Electric Multiple Unit Trains and Equipment" by Mr. F. A. Manley; (5) "Electric Signalling Systems for Rail and Road Transport" by Mr. D. G. Shipp.

Saturday, 26th May.—10 a.m. (6) "Electrification of Railways in the Commonwealth" by Messrs. E. L. E. Wheatcroft and H. H. C. Barton; (7) "Overhead Lines for Rail and Road Electrification Schemes" by Messrs. C. E. Allen and G. P. Goodman; (8) "Sub-Station Equipment for Rail and Road Systems" by Messrs. G. S. Causon and F. G. Stevens.

The rest of the programme remains as given.

Measuring and Control Apparatus

In 1940 in response to a request by the Board of Trade, Mr. W. G. Ardley, of George Kent, Ltd., took the initiative in forming the Meters and Measuring Export Group in order to encourage exports, allocate raw materials and so on. Arising from their association in this direction the firms concerned decided in 1944 to form a trade association to deal with a wider variety of problems and the British Industrial Measuring and Control Apparatus Manufacturers' Association ("BIMCAM") was set up with Mr. Ardley as first chairman. The industry covers the manufacture of apparatus for indicating, recording and controlling flow, pressure, temperature, level, gas analysis, specific gravity, humidity, conductivity, etc., and many specialized applications. In 1948 Mr. Ardley was elected the first president of the Association which now has 35 member firms. The second president is Mr. H. W. Blake, formerly of Tylors of London, Ltd., who took the chair at the Association's annual luncheon on 17th January.

Mr. Derek Walker Smith, M.P., Q.C., Parliamentary Secretary to the Board of Trade, referring to automation at the luncheon, contended that automation offered no threat to our economy—indeed the adoption of new techniques of mechanization was a necessary part of our industrial approach to reaching higher levels of productivity in conditions of full employment. The chairman of BIMCAM, Mr. G. A. Edwards, said that the annual production of their industry was now worth £20 million, a third of which was exported. Sir Walter Puckey, past-president of the Institution of Production Engineers, said that the biggest single managerial obstacle to-day was apathy on the part of workpeople. The biggest single managerial possibility was interest, and automation could provide this—it was one of the best and most potent managerial tools in that direction.

At the BIMCAM luncheon: Mr. H. W. Blake (president), Mr. D. Walker Smith, Mr. L. S. Yoxall and Sir Walter Puckey

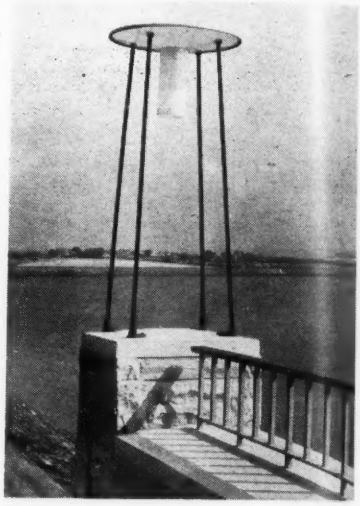
Proposed Merger of Unions

A meeting has been called for 29th February by the Amalgamated Engineering Union to consider a proposal that unions operating in the engineering industries should amalgamate. According to a report in *The Times*, nineteen unions of the thirty-one originally invited will be represented at the meeting; among them is the Electrical Trades Union.

The A.E.U. has a membership of over 853,000 in the British Isles and nearly 100,000 in Australia and South Africa. With those unions who have agreed to discuss the merger a total membership of over 1,400,000 will be represented. The United Pattern-makers' Association and the United Society of Boilermakers, Shipbuilders and Structural Workers are reported to have declined the A.E.U.'s invitation.

Aqueduct Lighting

Haweswater Lake is one of three lakes which supply Manchester with water. From Haweswater to Manchester, a distance of seventy-three miles, the pipeline runs underground, ending at the Inlet Well House, Heaton Park, a building of contemporary design constructed in natural stone. This original building is embellished by a symbolic bas-relief carved in Westmorland slate by Mitzi Cunliff. In keeping with the structure, the lighting fittings flanking both approaches to the entrances are simple contemporary standards supplied by Falk, Stadelmann & Co., Ltd., to the design of Mr. L. C. Howitt, city architect.



One of the lighting fittings supplied by Falk, Stadelmann & Co., Ltd., for the Haweswater Aqueduct

Works Visit

On 19th January, Mr. F. J. Erroll, M.P., Parliamentary Secretary to the Ministry of Supply, visited the British Thomson-Houston Co.'s radar factory at Blackbird Road, Leicester. During his tour Mr. Erroll was shown military radar in course of manufacture, including anti-aircraft fire control radar for the U.S. Army covering equipments for delivery to N.A.T.O. countries. He also saw work in progress on a $12 million contract placed by the U.S. Navy through the Hazeltine Electronics Corporation, equipment in hand for the British Government, including an airborne navigation and

bombing computer system, and the manufacture of marine radar equipment. Mr. Erroll was accompanied on his tour by Mr. H. L. Satchell (B.T.H. deputy director of manufacture), Mr. H. E. Cox (manager, Rugby Works) and Mr. R. H. Linnell (manager, electronic factories, Leicester).

New E.D.A. Film

The latest film produced by the British Electrical Development Association takes advantage of the interest created by a current television series by introducing Mr. Fred Emney, the comedian. It is called "Emney's Electrical Enterprise" and in a robustly humorous way puts over the case for electric water heating—mainly by demolishing specious arguments against it. It should prove popular with electricity showroom audiences, women's organizations, etc; it runs for 22 minutes and is available in 35 mm and 16 mm sizes. The film was produced and directed by Cecil Musk in association with the Film Producers' Guild.

E.D.A. has also produced a new film strip for use in the training of the sales staffs of electricity service centres. This, too, concentrates upon water heating and imparts its message in a humorous but effectively instructive way. It is in colour with the commentary spoken by Mr. J. A. Stedman, of E.D.A. The drawings are by Bob Godfrey and Geoff Hale.

Time Switches for Australia

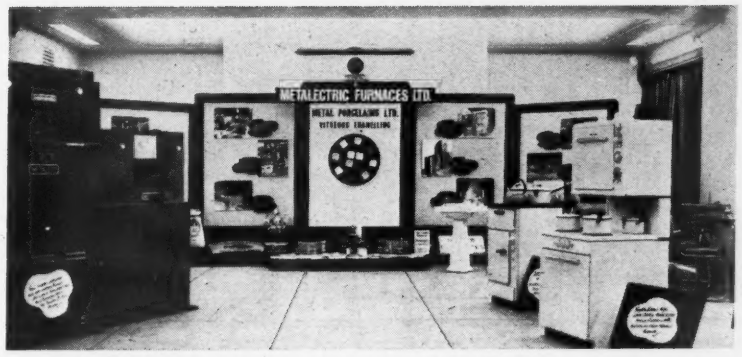
A further 20,000 time switches for controlling off-peak hot water systems have been ordered by the State Electricity Commission of Victoria from Venner, Ltd., through their Australian agents, H. Rowe & Co. Pty., Ltd. This follows on the completion of 25,000 of these precision instruments making a total of 45,000 valued at more than £350,000.

William McGeoch Extensions

In order to improve manufacturing facilities, William McGeoch & Co., Ltd., have recently added an extension to their factory. The ground floor is to be used as a new tool room and mould die making room. The first floor will be used as an extension of the Electronics and Guided Missile Departments, and will include space for two new bays, one for electrical testing and the other for prototype and development work.

Vitreous Enamelling in Electric Furnaces

In order to demonstrate to the vitreous enamelling industry the potentials of electric heating for firing and drying, an interesting exhibition was held recently in Birmingham by Metalectric Furnaces, Ltd., in conjunction with its associates, Metal Porcelains, Ltd., who manufacture the enamel, and by arrangement with the Midlands Electricity Board. The main working exhibit was a small continuous



The exhibition of electric furnaces in Birmingham by Metalectric Furnaces, Ltd.

furnace, typical of a number supplied to manufacturers of vitreous enamelled repetition parts. A model of a large continuous electrically-heated furnace installation, complete with drying oven and all ancillary equipment, was also displayed.

Small batch furnaces showing the general method of construction and simplicity of control, served to show the reliability and overall economy associated with modern electric thermal engineering practice. The durable high class finish obtained by the vitreous enamelling process, its use as a resistant to corrosion and heat, and means to create most pleasing decorative effects, was exemplified by a variety of appliances and ware which were also exhibited.

Interest in the exhibition was so marked that Metalectric Furnaces, Ltd., intends to repeat the exhibition in other parts of the country.

Hydro-electric Plant for India

The Metropolitan-Vickers Electrical Co., Ltd., through its associated company, Associated Electrical Industries (India), Ltd., has obtained an order from the Punjab Government covering five water-turbine driven a.c. generators for the first stage of the Bhakra Dam project on the Sutlej River in Northern India. Each will have an output of 100,000 kVA at 166·7 r.p.m., generating at 11 kV, three-phase, 50 c/s and 0·9 power factor. They are to be driven by Francis type turbines of 125,000 h.p. each. The generators will be of the vertical-shaft type with a thrust bearing above the rotor and two guide bearings, one above and one below. Among the ancillary equipment included in the order are five Type VTSR automatic voltage regulators, which are of the quick-response magnetic amplifier type. The order is one of the largest ever received by a British manufacturer for this type of equipment, being valued at over £1,000,000, and the project, when completed, is expected to be the largest hydro-electric scheme in Asia.

Electric Tool Sales Conference

Speaking at the 1956 sales conference of Wolf Electric Tools, Ltd., held at St. Ermin's Hotel, London, S.W.1, from 9th to 12th January, Mr. R. F. Hatto, sales director, told representatives of the company and its stockists that 1955 had been a record year, but while sales had been the highest ever it was still necessary for sales representatives to continue creative selling. During the coming year it was planned to introduce several new industrial and "Cub" tools, details of which would be released when they were ready for production. Mr. L. J. Cox, public relations officer, gave a review of the sales promotion and advertising programme that had been carried out during the past twelve months and plans for the future.

Change of Name

The name of Beck & Pollitzer-Strand Electric, Ltd., is being changed to Beck & Pollitzer (Electric), Ltd. The holding in the company of Strand Electric has been acquired by Beck & Pollitzer (Contracts), Ltd.

Trade Announcement

The **Agro Electrical Co., Ltd.**, 60-66, Wardour Street, London, W, announces that from 1st February Mr. Norman W. Jackson, Greystones, Conningham, Yorks, is taking over its representation in the counties of Northumberland, Durham, Westmorland, Cumberland, Yorkshire and Derbyshire.

TRADE MARKS

APPLICATIONS have been made for the registration of the following trade marks. Objections may be entered up to 4th February:—

LADY SUNBEAM. No. 746,965, Class 8. Electric dry shavers and parts.—Sunbeam Corporation, Chicago, U.S.A. Address for service, c/o Frank B. Dehn & Co., Kingsway House, 103, Kingsway, London, W.C.2.

SYLVANIA SILVERSCREEN. No. 745,642, Class 9. Cathode ray tubes.—Sylvania Electric Products, Inc., Salem, Mass., U.S.A. Address for service, c/o Wildbore & Gibbons, 101, Leadenhall Street, London, E.C.3.

SPOTSEL. No. 747,460, Class 9. Apparatus for electrical resistance welding.—La Soudure Electrique Languepin, Paris, France. Address for service, c/o Haseltine, Lake & Co., 28, Southampton Buildings, Chancery Lane, London, W.C.2.

WARM-GLOW. No. 724,956, Class 10. Electrically heated blankets.—Warm-Glow Co., Ltd., Progress Road, Eastwood, Leigh-on-Sea, Southend-on-Sea, Essex.

GENERATION AND DEVELOPMENT

Output Increases by 10 Per Cent

As briefly reported in our last issue, the Ministry of Fuel and Power's latest monthly statement shows that a total of 80,151 million kWh was generated last year by the Central Electricity Authority, the North of Scotland Hydro-Electric Board and the South of Scotland Electricity Board, an increase of 7,255 million kWh over the previous year's output. The rate of expansion (10 per cent) was lower than in 1954 (11·3 per cent) but well above the increases in the preceding three years (5·7, 4·0 and 9·1 per cent, respectively). During March, 1955, when the average temperature remained continuously below that of 1954, output rose by 17·2 per cent.

Of the total electricity generated last year, 78,836 million kWh was produced by steam plant, an increase of 11 per cent, while hydro-electric output (1,146 million kWh) declined by nearly 35 per cent. In thermal stations 42·9 million tons coal, coke and breeze was burned, against 39·6 million tons in 1954. There was a further increase in fuel oil consumption to 216,300 tons from the 174,400 tons consumed in 1954 and 96,000 tons in 1953.

At the end of the year the aggregate installed capacity was 22,489 MW, a net increase of 1,922 MW (9·3 per cent). This total included 20,533 MW in C.E.A. stations, where 612·5 MW of generating plant and 2·8 million lb/hr of boiler plant were added in December, as follows:—

Battersea "B"—425,000 lb/hr boiler (Babcock & Wilcox); Portishead "B"—360,000 lb/hr boiler (Mitchell Engineering); Staythorpe "A"—60 MW set (B.T.H.) and 240,000 lb/hr boiler (Babcock & Wilcox); Fleetwood—300,000 lb/hr boiler (Richardsons, Westgarth); Marchwood—60 MW set (English Electric); Drakelow "A"—60 MW set (English Electric); Carmarthen Bay—two 240,000 lb/hr boilers (Babcock & Wilcox); Doncaster "B"—two 180,000 lb/hr boilers (Mitchell Engineering); Keadby—60 MW set (C. A. Parsons & Co.); Skelton Grange "A"—60 MW set (C. A. Parsons); Wakefield "B"—60 MW set (English Electric Co.) and 550,000 lb/hr boiler (Foster Wheeler); Stella South—60 MW set (C. A. Parsons & Co.); Carrington—60 MW set (Metropolitan-Vickers); 360,000 lb/hr boiler (John Brown); Fleetwood—30 MW set (English Electric Co.); Woolwich—30 MW set (G.E.C.) and 180,000 lb/hr boiler (John Thompson); Cowes—12·5 MW set (Brush Electrical Engineering Co.); and Ince—60 MW set (G.E.C.).

Transporting Large Transformers

Six 124-ton transformers, the largest ever conveyed over the Southern Region of British Railways, are being moved by stages to the Central Electricity Authority's new power station at Marchwood, near Southampton, from the Hollinwood Works of Ferranti, Ltd. The transformers, each 18ft 6in long, are loaded on new British Railways transformer trolleys with special traversing arrangements enabling the load to pass bridges, signals and other lineside structures, where sufficient clearance would not otherwise exist. A special train is being used throughout, and is being hauled by a diesel locomotive from Reading to Totton.

Development in the North East

The quarterly report of the North Eastern Electricity Board submitted to a meeting of the Electricity Consultative Council stated that during the quarter development schemes costing £905,229 had been approved. These included 83 schemes for housing and 189 for rural supplies. It was also reported that 231 new substations had been commissioned, and in addition, h.v. supplies had been afforded to 22 industrial and commercial consumers. A total of 155 miles of cable had been brought into use; 369 agricultural premises had been connected, and negotiations completed for supplying a further 535. Five more villages were supplied with electricity during the three months.

Kincardine Generating Station

The South of Scotland Electricity Board has placed a contract with C. A. Parsons & Co., Ltd., for the manufacture, delivery and installation of the No. 1 120 MW turbo-alternator, condensers and feed heating plant at the Kincardine generating station. The contract sum amounts to over £1 million and the set is scheduled for commissioning in 1958.

Plant Construction in Canada

Canada's power plant capacity increased by 5 per cent in 1955 and promises to grow faster in the next two years. The Northern Affairs Department, in a year-end review of the power industry, said that the 1955 increase in generating plant of 839,630 h.p. brought the total capacity to 17,531,536 h.p. More than half the increase this year was accounted for by the addition of five units with a total capacity of 525,000 h.p. at the Ontario Hydro-Electric Power Commission's Sir Adam Beck-Niagara No. 2 generating station. The rise in generating capacity during 1955 was smaller than the average increase for the last five years of 1,014,000 h.p., but the Department said that projects now under construction would add about 1,000,000 h.p. in 1956 and as much in 1957. Projects still in the preliminary stages would provide an additional 4,000,000 h.p., including the huge St. Lawrence River power project which was scheduled to provide 1,200,000 h.p. by 1960. The Department estimated that only 27 per cent of the country's total water power resources had yet been harnessed.

Hydro-electric projects under construction in Ontario, besides the St. Lawrence development, were a 74,000 h.p. generating station at Manitou Falls on the English River, scheduled for completion next year, and the Whitedog Falls generating station on the Winnipeg River which was expected to provide 243,000 h.p. in 1957. In Quebec, hydro-electric construction, stimulated by mining developments and the growth of the aluminium industry, continued to expand. The Shawinigan Water and Power Co. added 158,500 h.p. with the installation of new units in its three St. Maurice River plants. The first three 150,000 h.p. units were expected to go into service next year at the Quebec Hydro-Electric Commission's Bersimis River project and construction was going forward on the No. 3 plant at Beauharnois on the St. Lawrence where an initial installation of about 450,000 h.p. was planned, with an ultimate capacity of 675,000 h.p. Preliminary studies were being conducted on the first stage of the 900,000 h.p. Lachine development.

ELECTRICITY GENERATED AND PLANT INSTALLED

	Fuel consumed Thousand tons			kWh generated Millions			kWh sent out Millions	Installed capacity (m.c.r.) MW
	Coal	Coke and Breeze	Oil	Steam	Water power	Total		
Central Elec. Authority	3,881	78	20·3	7,368	8	7,388	6,939	20,533
N. of Scotland H.E.B.	29	—	1·5	44	108	159	156	704
S. of Scotland E.B.	281	6	0·2	511	40	551	525	1,252
Total for December, 1955 ...	4,191	84	22·0	7,923	156	8,098*	7,620	22,489
Corres. total for December, 1954	3,827	98	24·5	7,046	293	7,354	6,933	20,567
Inc. or dec., per cent	+9·5	−14·3	−10·2	+12·4	−46·8	+10·1	+9·9	+9·3
Total to date (12 months) 1955	41,883	1,018	216·3	78,836	1,146	80,151	75,329	
Total for corres. 12 months of 1954	38,539	1,105	174·4	70,993	1,759	72,896	68,565	
Inc. or dec., per cent	+8·7	−7·9	+24·0	+11·0	−34·9	+10·0	+9·9	

* The total figure includes generation by other methods amounting to 19 million kWh.

Financial Section

STOCKS and SHARES

THE PRIME MINISTER'S speech at Bradford a week ago had the effect of drawing attention to the precariousness of the financial situation, and was necessarily indefinite about any new measures that might be introduced if present weapons were found to need reinforcement in the battle against inflation. Stock Exchange markets seemed subsequently to resign themselves to a further period of waiting upon events for signs of a change in the economic weather, and upon next April's Budget for any positive alteration in the direction of affairs under the new Chancellor. Meanwhile markets remained dull and inactive.

Atomic Power Group

In a generally poor start to the present year, the shares of companies in what the market calls the "atomic power group" gave a particularly weak lead. Depression seemed to be aggravated by talk of big new issues in the offing, and by loss of enthusiasm for shares showing comparatively low yields on the basis of the latest dividends. With less than three weeks of the year completed, several of the leaders in the electrical equipment market were heavily down. A.E.I. at 74s, and Reyrolles at 98s 6d, were both showing depreciation to the extent of about half a sovereign in that short space of time. C. A. Parsons at 75s were some 8s 6d down, while English Electrics and G.E.C., at the common level of 60s 3d., and also Babcocks at 78s 9d, had lost between four and five shillings apiece before resistance stiffened upon the appearance of new buyers at the reduced levels.

Coming Dividends

Part at least of the fall in prices referred to above could well be ascribed to a revision of estimates concerning the coming final dividend declarations on account of 1955. One effect of the credit squeeze, it is thought, will almost certainly be a heightened disposition in boardrooms to conserve, rather than distribute, any increases in earnings. If precedent is followed, English Electric will be the first of the big electrical groups in the field with their announcement of the annual results. Last year, the final distribution was declared in mid-February, with the A.E.I. statement following within a fortnight. For Parsons, Reyrolle and Babcocks the usual month is April. The G.E.C. financial year runs until March, and the dividends are due to be declared in February (interim) and July.

Phœnix Telephone Issue

Shareholders of Phœnix Telephone & Electric Holdings are being offered new 5s ordinary shares, on a one-for-four basis, at a price of 10s 3d. These have been changing hands in the market at a premium of about 1s 9d, representing an all-in price of 12s, and they will be transferable free of stamp duty for the next few weeks. In a statement accompanying the issue, the directors say that they believe that it will be possible to pay a 15 per cent dividend, on the larger capital, for the year ending with February, so that the prospective yield on the shares is of the order of 6¼ per cent. Dividends at the rate forecast were paid for the two preceding years, when earnings were running each time at the equivalent of about 40 per cent on capital of just under £200,000.

Colvern Holdings

The 5s ordinary shares of Colvern Holdings, which were among the most popular of last year's introductions to the industrial market, have been quoted lately at around 18s 9d. This is about the same price as that at which early dealings took place last July, since when the quotation has been up to 22s. The financial year of the company ends next March. In the statement published at the time of the issue, the directors estimated profits at £160,000 and indicated a dividend at the rate of 20 per cent for the period. This would place the shares, at the above price, on a yield basis of 5·3 per cent. Business of the operating company was described in the prospectus as the manufacture of component parts for the electronic industry and, in particular, of potentiometers and variable resistors. The capital is £175,000 in ordinary shares.

Westinghouse New Shares

Investment having reverted to a mood of reluctance to take on new commitments, substantial "rights" issues of capital are again having a tendency to weigh heavily for a time upon the shares concerned. New shares to the value of £2·1 million offered to shareholders of Westinghouse Brake & Signal make a case in point. Before the issue, the old shares had already fallen by about 10s on a measure of disappointment over the 12 per cent decline in 1954-55 net profits. Subsequently, the price came down by the equivalent (allowing for the value of the rights) of a further 8s or so. It stood recently at 77s ex-rights, with the quotation for the new at 8s premium on the issue price of 70s. On these new shares, calls are due of 30s on 2nd February, and 40s on 12th April, until when they will be transferable free of the usual 2 per cent stamp duty.

The Westinghouse Brake & Signal report does not mention dividend prospects on capital increased by the new share issue; but with the last payment covered thrice by earnings, and taking account of the tenor of the chairman's review, the market feels it safe to assume at any rate the maintenance of the distribution at 18 per cent. On that basis, the shares are now offering a yield of 4¾ per cent. In the report are references to large increases in output capacity, a record order book, a substantial improvement in current sales, and the diversity of the group's interests in the fields of railway, colliery, electrical and other industrial equipment. They lead up to the chairman's conclusion that on the current and, in particular, the long-term view, prospects of the group are good.

Aiton's Interim Report

Having announced earlier the maintenance of the interim dividend for the current year at 7½ per cent, Aiton & Co. have now issued an interim report on the progress of business. This says that the company continues to book orders at a satisfactory rate and to receive a very large number of inquiries. Results for the twelve months ending in March are unlikely to differ much from those of the previous year, and it will remain necessary to retain a large proportion of earnings for capital expenditure purposes, even if some desirable but less immediately essential schemes are postponed in accordance with national policy. For 1954-55, dividends totalling 20 per cent were paid from earnings equivalent to 133 per cent on the £250,000 ordinary capital. On this basis, the yield on the 10s shares at 47s works out at 4¼ per cent.

Science and Technology Award

The London County Council is inviting applications for the award of the 1956 Robert Blair Fellowship, which is tenable for one year of advanced study or research overseas in applied science and technology. The value of the award varies according to the country chosen by the person to whom the award is made and may be as much as £2,000 if the country selected is Canada or the United States. The closing date for receipt of applications for the 1956 Fellowship is 1st March next, and particulars and application forms can be obtained from the Education Officer (WA.14), at the County Hall, S.E.1. Candidates must be at least 21 years of age. Fellowships are open to suitable candidates who have been trained in applied science and technology, but preference is given to engineering science and to those who have completed a course of study in London institutions or who have been identified with the London teaching service.

REPORTS and DIVIDENDS

Associated Electrical Industries, Ltd., has formed a new company, Siemens-Ediswan, Ltd., "to facilitate administration within the group." The present Edison Swan Electric Co., Ltd., and Siemens Brothers & Co., Ltd., are to retain their identities. Sir William Morgan is chairman of the new company with Dr. J. N. Aldington as managing director. Other members of the board are Dr. T. E. Allibone, Mr. J. S. A. Bunting, Mr. G. W. Griffin, Mr. W. H. Grinsted, Mr. W. A. Patterson, Mr. J. W. Ridgeway and Mr. J. T. Thornhill. Messrs. R. L. Basset, A. N. E. McHaffie and A. F. Street are non-executive directors.

Broadcast Relay Service, Ltd., has obtained Treasury consent to raise £1,330,000 by an issue of ordinary shares to provide funds for the development of the business. It is proposed that the new shares shall be offered to existing ordinary stockholders, but the price at which they will be issued and the number to be issued will depend largely on market conditions prevailing at the time. As a preliminary to this issue, and to allow a margin of unissued ordinary capital, it is proposed to create 3·2 million 5s shares, making 4,739,128 shares available for issue. An extraordinary meeting to create the capital will be held on 3rd February.

Enfield Rolling Mills, Ltd.—Approximately 96½ per cent of the 118,750 £1 ordinary shares provisionally allotted were accepted. The issue was of 130,000 £1 ordinary shares at 62s each. The excess shares were heavily oversubscribed and applications have been substantially scaled down. It is announced that the company has now completed the purchase of the issued capital of the Watliff Co., Ltd.

R. B. Pullin & Co., Ltd., report a profit for the year to 30th September last of £171,130, as compared with £141,578 for the preceding year. After providing £77,916 for taxation, the net profit is £93,214 (against £65,542). It is proposed to pay a final ordinary dividend of 15 per cent (against 10 per cent), making 20 per cent for the year (15 per cent).

Lindley Thompson Transformer (Holdings), Ltd.—The profit for the year ended 30th September last is £87,572, as compared with £97,969 for 1953-54. From this is deducted taxation of £42,105. It is proposed to pay a dividend for the year of 12½ per cent (unchanged).

New Companies

Vactric (Control Equipment), Ltd.—Registered 13th January. Capital £50,000. To acquire the business of control equipment manufacturers carried on by Vactric, Ltd., at 19-21, Brunel Road, London, W.3, etc. Solicitors: William A. Crump & Son, 10-11, Lime Street, London, E.C.3.

Siemens-Ediswan, Ltd.—Registered 13th January. Capital £100,000. To acquire shares, stocks, etc. Power is taken to carry on the business of electrical and mechanical engineers, producers and suppliers of electricity, manufacturers of and dealers in mechanical and electrical machinery and apparatus, etc. Further particulars are given on this page.

Wilde & Sons (Barrow), Ltd.—Registered 12th January. Capital £6,000. To acquire the business of electrical and general engineers, welders, contractors and ship repairers carried on by E. and J. Wilde as Wilde & Sons, at Barrow in Furness, etc. E. Wilde is permanent managing director. Regd. office: 4, Ayr Street, Barrow in Furness.

Horridges of Middleton Ltd.—Registered 12th January. Capital £5,000. To acquire the business of an electrical retailer and contractor carried on by A. Horridge, etc. Directors: A. Horridge and Ada Horridge. Regd. office: 6/8, Old Hall Street, Middleton, Manchester.

B. & W. Electrical Engineers, Ltd.—Registered January 11th. Capital £500. Directors: B. H. Welsman and C. E. Bredl. Registered office: 399, Twickenham Road, Isleworth, Mdx.

Increases of Capital

Fredk. Mountford (Birmingham), Ltd.—Increased by £100,000, in £1 ordinary shares, beyond the registered capital of £100,000.

Electric Repairs (Nottingham), Ltd.—Increased by £9,000, in £1 ordinary shares, beyond the registered capital of £1,000.

Reliance-Clifton Cables & Industrial Products, Ltd.—Increased by £250,000, in 5s "A" non-voting ordinary shares, beyond the registered capital of £750,000.

Meeting of Creditors

Alexander Electrical Co., Ltd.—A meeting of creditors, pursuant to section 293 of the Companies Act, 1948, will be held on 3rd February at 5, Mansfield Street, London, W.1, for the purposes mentioned in sections 294 and 295 of the Act.

Liquidation

Electrical & Radio Installations (Ealing), Ltd.—Second dividend of 10s in the £, payable at the offices of Elles, Reeve & Co., 4, Bucklersbury, E.C.4.

Bankruptcies

C. C. A. Bright, 5, Nestor Court, Preston Road, Brighton, electrician.—Receiving order made 10th January on debtor's own petition.

T. D. Long, 664, Halifax Road, Buttershaw, Bradford, electrical contractor.—Trustee, Mr. R. B. Smith, Flat 1, 34, Kent Road, Harrogate, released 1st November.

J. W. Luker and **H. A. R. Phillips,** lately carrying on business in partnership at East Street, Lewes, Sussex, and at 206, High Street, Lewes, under the style of Gordon & Luker, electrical contractors.—Last day for receiving proofs for dividend 31st January. Trustee, Mr. J. S. Hole, 7, Old Steine, Brighton, 1.

F. Robinson, 78, Scholes, and 112, Frog Lane, Wigan, electrical contractor.—Last day for receiving proofs for dividend 31st January. Trustee, Mr. A. K. Ferguson, West Africa House, 25, Water Street, Liverpool, 2, Official Receiver.

South African Electrical Trade

The following statement of the values of the leading groups of electrical imports into the Union of South Africa in 1954 is based on the monthly abstract of trade statistics recently issued in Pretoria. The total amounts to nearly £12 million, compared with just over £11,500,000 in 1953. Countries of origin are not specified. The share of the United Kingdom in the Union's aggregate imports is, however, recorded. It was £152·6 million out of £443 million in 1954, compared with £159·5 million out of £425·5 million in 1953.

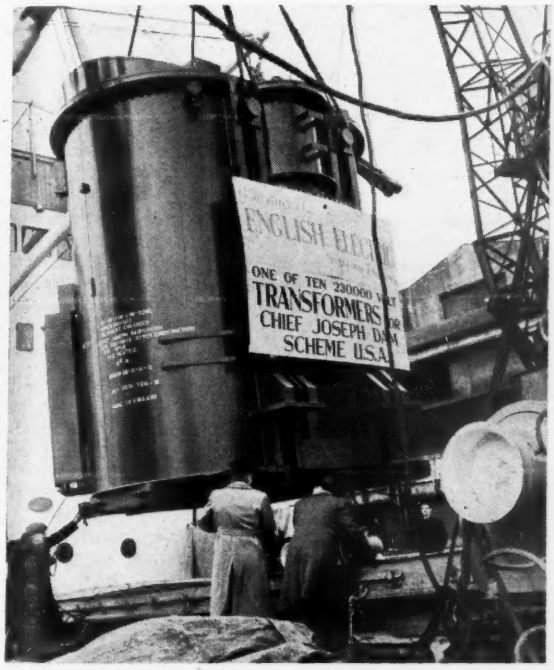
The Union's exports of electric cable and wire totalled £777,500 last year against £1,192,500 in 1953, of batteries, not rechargeable, £106,000 (£113,000), and of batteries, rechargeable, £208,000 (£162,000), while those of machinery and parts, excluding agricultural, figured at £6,333,000, or rather less than in 1953.

Class of Equipment	1953 £ (000)	1954 £ (000)	Inc. or dec. on 1953 £ (000)
Batteries and parts	687	608	— 79
Dynamos and generators	3,548	4,157	+ 609
Motors	2,147	2,023	— 124
Transformers	1,961	2,251	+ 290
Cable and wire, rubber insulated ...	421	274	— 147
Cable and wire, other	1,438	1,167	— 271
Electric stoves and parts	176	235	+ 59
Lamp bulbs	390	433	+ 43
Radio and wireless apparatus and accessories	1,775	1,836	+ 61

Progress in Manufacture

The English Electric Co.'s Activities in 1955

LAST year was a busy period for the English Electric Co., Ltd., in all fields of manufacture. Outstanding among the orders received was that by the steam turbine division for three 200 MW sets for the High Marnham power station of the Central Electricity Authority. These are the largest turbo-alternator sets so far ordered in this country and are to operate at 2,350 lb/sq in, 1,050 deg F, re-heating to 1,000 deg F. Other C.E.A. orders placed for turbines included the fourth 100 MW set for Willington, the sixth 60 MW set for Marchwood and the third and fourth 60 MW sets for Belvedere power station. Export orders included two 60 MW sets for South Australia, a second 45 MW set for Nova Scotia and



One of ten transformers for the Chief Joseph Dam, U.S.A., being on-loaded at Liverpool Docks

30 MW sets for South Africa, New Zealand and Hong Kong.

The transformer department received contracts for two 210 MVA, 275 kV transformers for High Marnham and 120, 90, and 72 MVA 132 kV units for other sites of the C.E.A. Outstanding among the export orders are undoubtedly those for America, including two 120 MVA, 230 kV transformers for the St. Lawrence Seaway and 120 MVA and 200 MVA transformers for Missouri and the Tennessee Valley respectively. During the year a 310 MVA, 230 kV three-phase bank was despatched to the Chief Joseph Dam in the United States. Other large overseas orders were from Australia, Holland and Turkey.

The demand for the company's switchgear was heavy during the year and included orders for new 132 kV sub-stations for the North of Scotland Hydro-Electric Board and Uttar Pradesh, India.

Among electrical plant contracts was one for six 2,030 h.p. 6,600 V two speed motors for driving induced draught fans for the boilers at High Marnham. These six machines will be the largest high voltage two speed motors for power station service in Great Britain. Another interesting item of plant is a 20 MW frequency changer for use in British Columbia in connecting up 60 c/s and 50 c/s networks. During the year electrical driving equipment was ordered for jute mills in Thailand, India and Pakistan.

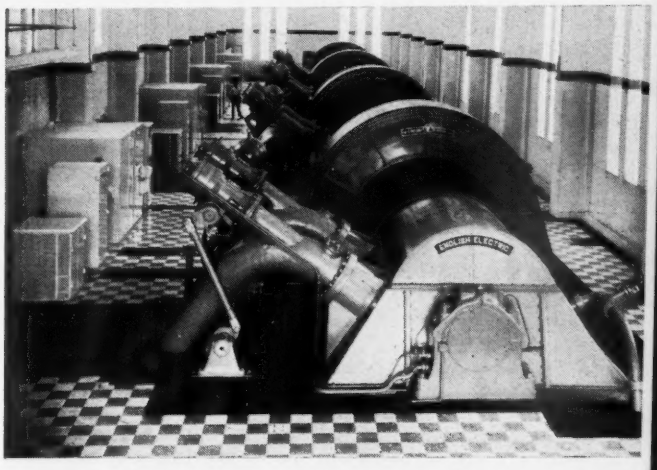
A new range of protected type industrial motors was introduced early in the year and has been particularly well received in dollar markets because of interchangeability with American standards.

The metal industries division has supplied many large equipments including complete electrical drive and control equipment totalling some 19,000 h.p. for a new 5-stand cold tinplate mill in South Wales. Hot mill drives were installed during the year at plants in the United Kingdom, Norway and France, the equipment for the last named country being an 8,050 h.p. twin drive on a 160in 4-high reversing mill, the first such drive in France. Among orders received was one for a 12,000 h.p. twin drive for a high lift slabbing mill which will be one of the largest in the world.

The mining division received many orders during the year for geared a.c. drum winders including many for the National Coal Board for tower-type multi-rope friction winders, three of these being driven by single overhung 2,000 h.p., d.c. winder motors operating under Ward-Leonard control. The multi-deck cage and counterweight system will be used and, in addition to conventional manual control from the tower a control desk with single-lever control will be provided together with push-buttons for semi-automatic operation.

Substantial orders from overseas continued to be

Four 12,000 kW horizontal impulse hydro-electric sets in the Sengulam power station of the Travancore–Cochin Government, India

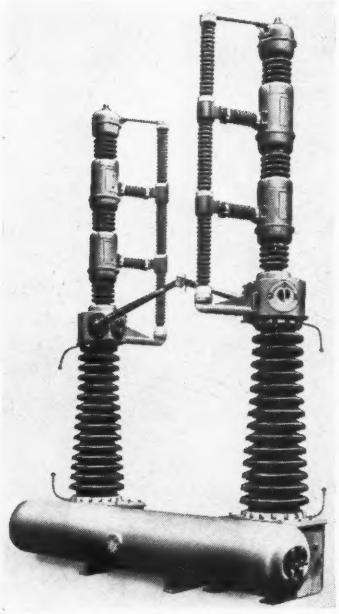


received during the year by the hydro-electric department. These included an additional 25,000 h.p. horizontal impulse turbine and alternator for Tully Falls, Queensland, and two additional turbines each rated at 129,200 h.p. for the Snowy Mountains Hydro-Electric Authority. An additional 8,050 h.p. set was ordered from S. Africa and one of a similar size for Travancore, India. The associated organization, John Inglis Co., Ltd., of Canada, obtained the order for all sixteen turbines on the Canadian half of the St. Lawrence Seaway development. These machines will each provide 75,000 h.p. at 81ft head and will be of the vertical fixed propeller type running at 94·7 r.p.m.

Orders received at home by the traction department during 1955 for diesel-electric locomotives included 1,000, 1,100 and 2,000 h.p. locomotives for British Railways and 800 h.p. diesel-electric equipment for the Southern Region of British Railways, where over 1,000 motor coaches now have English Electric equipment. Delivered overseas were 2,000 h.p. locomotives for Rhodesia, 750 h.p. mixed traffic locomotives for New Zealand, the Gold Coast and Nigeria and 400 h.p. shunting locomotives for the Netherlands. The 3,300 h.p. Deltic diesel-electric locomotive is at present undergoing tests on British Railways. Many orders for straight electric traction were also received.

Rectifier plant was in demand for use in many fields, such as radio, traction and steel manufacture. A further eight 2,500 kW units were commissioned on the Southern Region of British Railways as part of their programme of replacement of old rotary convertors. Orders for new traction equipments included four 1,500 kW units for Athens and a 600 kW unit for an installation in Holland. A new hot strip mill of Steel, Peech & Tozer, Ltd., uses two 3,500 kW, one 1,000 kW and two 500 kW equipments, provided with grid control for motor starting, inching and speed variation. Among overseas orders were two 1,500 kW units for the Burnpur Works of the Indian Iron & Steel Company.

Considerable progress was achieved in the sphere of electrical instruments and several new models for switchboard and panel mounting were introduced. Among interesting developments were a 360 deg 4-quadrant power factor indicator for use on all circuit arrangements of single-phase and polyphase, balanced or unbalanced loads and three-wire or four-wire systems.



A single phase of a 275 kV air-blast circuit-breaker

Erection has started at the Royal Aircraft Establishment, Bedford, of two 20,000 kW gas turbines and testing of the high pressure units for these is now taking place on site. A 2,500 kW gas turbine has been erected at the Stafford Colliery, Stoke-on-Trent, of the National Coal Board. This will run on methane and is due for commissioning shortly. Work is also proceeding on a 2,000 kW gas turbine for the Metropolitan Water Board.

Diesel engine production was well maintained and larger diesels in the SRL range of 625 to 2,000 h.p. were ordered by many overseas countries including Iraq, Colombia, Gambia and Egypt. An interesting installation now on site is the 500 h.p. package unit for a sludge pump in the Robitos oilfield. This type of portable unit has proved very popular.

The domestic appliance and television section has introduced four major products over the last twelve months. At the British Electrical Power Convention the raised oven automatic cooker was shown for the first time. This cooker breaks completely away from conventional design, having a self-contained unit with the oven raised above the hob. In the autumn two new washing machines—of similar capacity and dimensions—were introduced, one having a 3 kW immersion heater. A multi-channel television receiver with a 21in cathode ray tube was also made available during the year and this is also equipped with v.h.f. frequency modulated sound reception for the B.B.C. programmes.

NEW BOOKS

High Vacuum Technique. By J. Yarwood. Pp. 208; figs. 110. Chapman & Hall, Ltd., 37, Essex Street, London, W.C.2. Price 25s.

This popular monograph, mainly intended for users of vacuum apparatus, has now reached its third edition and it differs from the earlier ones mainly by the inclusion of new material. Among the more important additions are an account of the gas ballast pump (used when the vacuum system contains condensable vapours), new vacuum materials, the specialized methods used in producing and measuring vacua of better than 10^{-8} mm Hg and leak detection.

The overall plan of the book is unchanged. Chapter 1 describes the production of high vacua, i.e. the operation and use of mechanical and diffusion pumps, their characteristics and use in systems. Chapter 2 is on the measurement of high and ultra-high vacua. Chapter 3 deals with pumping speed, its measurement and calculation. Chapter 4 is on out-gassing and gettering. Chapter 5 deals with the more classical applications of high vacuum in industry, while Chapter 6 summarizes the physical properties of some materials used in vacuum work and vacuum systems. The book is copiously illustrated and contains large numbers of tables, giving manufacturers' data on pumps, pumping fluids and similar useful data.

The revisions could have been more complete; for instance, under oils and greases there is no mention of Apiezon "C" oil or of Apiezon "T" grease. There is no circuit for a good modern electronic stabilizer for an ionization gauge. The section on beryllium does not mention the considerable health hazard represented by this material. The inventor of the copper-glass seal has his name wrongly spelled as "Housekeeper" throughout the book. Few people would agree that Kovar is best copper-plated before sealing to glass. The book forms a very useful first introduction to vacuum technique but more serious students will often find it necessary to consult fuller accounts.—A.H.B.

Questions and Answers on Refrigeration. By M. E. Anderson, A.M.I.Mech.E. Pp. 160; figs. George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2. Price 6s.

Modern Clocks. By T. R. Robinson, F.B.H.I. Third edition. Pp. 283; figs. N.A.G. Press, Ltd., 226, Latymer Court, Hammersmith, London, W.6. Price 30s.

Noise. By A. Van der Ziel. Pp. 450; figs. Chapman & Hall, Ltd., 37, Essex Street, London, W.C.2. Price 60s.

Electric Fence Controllers

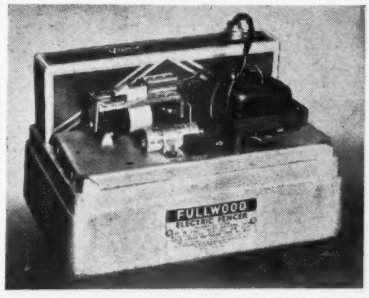
Their Construction and Characteristics

By H. BURTON, B.Eng., M.Sc., A.M.I.E.E.*

BECAUSE of their cheapness and the ease with which they can be transferred from one site to another, electric fences are becoming an important feature in agriculture. In view of this, many people with electrical responsibilities in rural areas may wish to obtain some knowledge of electric fence controllers, the principles on which they are designed, and the way in which they operate.

The principal design requirement of an electric fence is that it should provide a shock which is an effective deterrent and yet which is safe to humans and animals. Because of the importance of this latter point, most countries in which electric fence controllers are used in quantity have prepared standards which include maximum output provisions.

The specification of a safe form of output is difficult, since reliable data on the lethal effects of electricity are scarce, and the external conditions in which the shock is applied may vary widely, e.g. in drought and in wet weather. Continuous direct voltages have no deterrent effect, and so need not be considered. The danger limit with continuous alternating voltages occurs when the "hold-on" current is reached, so that a person is unable to release himself from the electrified wire by his own volition because of muscular contraction. When a fence is excited with an uninterrupted alternating voltage, it must be impossible for the "hold-on" current to be delivered by the controller under any conditions. Only a few countries permit this type of controller, and they require that the maximum current which can be delivered by the controller shall be less than either 5 or 8 mA. Simple expedients, such as connecting a resistor between a mains supply and the fence, have led to many fatal accidents because of ineffective current limiting. Unfortunately, reports of such happenings sometimes do not distinguish between "electric fences" and "electrified fences."



Battery-operated capacitive discharge controller

Most national and international standards, e.g. the British and the C.E.E. standards, recognize only the intermittent type of controller, in which very short pulses of voltage are generated at intervals of about 1 sec, so that for most of the time the fence is not energized and "holding-on" cannot occur. Specification of the output of an intermittent type of controller is further complicated by the different shapes of pulse which are delivered by different varieties of controller, few of which give a pure waveform.

All the specifications of output drawn up in different countries now stipulate a maximum permitted pulse current, or some related current, with a maximum length of pulse and rate of pulsing, combined with a maximum permitted quantity of electricity in each pulse. Approximate figures are:—Peak current (max) 500-1,000 mA; pulse duration (max) 0·1 sec; time between pulses (min) 0·75 sec; and quantity of electricity per impulse (max) 3 mC, although there are minor variations between different specifications. The limiting current and quantity of electricity are normally measured for a load resistance of 500 ohms, which is considered to be the minimum resistance of the human body under any conditions.

The existing specifications, based with large factors of safety on the available data on the physiological effect of electricity, have proved in practice to be sound. There are records of only two fatal accidents occurring with approved types of fence controller properly installed, both of these being in the United States. In view of the large number of units in operation throughout the world, this represents an extremely low level of risk.

Battery-Operated Controllers

Electric fence controllers may be supplied from batteries or from the mains, and since the two types differ in important design factors they are best discussed separately. The majority of controllers in Britain are of the battery-operated type, supplied from accumulators: a 6 V car battery is a common source of power. The only British Standard as yet issued on this subject (B.S. 1222) refers to this type of unit in which the operating voltage does not exceed 8 V. A type of controller not dealt with in the Standard uses a dry battery of the radio type, giving about 100 V.

B.S. 1222 distinguishes between "inductive discharge" and "capacitive discharge" controllers. In fact, capacitive discharge controllers operating on a 6 V supply are rare. Low-input-voltage controllers are generally of the inductive discharge type, while high-input-voltage types use the capacitive discharge.

All types of inductive discharge controllers are similar in principle, although the details of the mechanism vary. It is not practicable to describe the products of all the individual manufacturers, but a common form of unit is shown in Fig. 1 and the general principle of operation can be understood from this.

The operation of the circuit is identical with that of the induction coil or d.c.-operated electric bell, except that the armature vibrating at high speed is replaced by a heavy flywheel restrained by a hairspring so that the primary circuit is made only about once per second. Each time the primary circuit is broken, a high-voltage pulse is induced in the secondary winding. The rate of pulsing depends primarily on the flywheel inertia and the setting of the hairspring, but also increases rapidly with decreasing supply voltage. From the practical point of view, this latter characteristic gives a convenient indication of the state of the battery.

The circuit of a typical capacitive discharge controller is shown in Fig. 2. Relay A/1 is of the standard Post Office type, and its armature is the only moving part in the unit. When the controller is switched on, the capacitor C draws a comparatively large current from the battery so that A/1 operates. Contact A1 then opens and isolates the capacitor from the output transformer T. The voltage

* National Institute for Research in Dairying, University of Reading.

of the capacitor rises exponentially, and the current drawn from the battery decreases correspondingly, until the relay will no longer hold in. Contact A1 then closes, and discharges the capacitor through the primary of the output transformer so producing the high-voltage output pulse. The capacitor once more draws a high current and the cycle is repeated.

The rate of pulsing with this type of controller is inversely proportional to the time constant RC, and also depends on the relay characteristics, so that it is not controllable by any mechanical adjustment. The rate falls to some extent as the battery voltage falls. The output pulse energy depends on the size of the capacitor C, and the voltage at which it discharges, which is dependent on the releasing current of the relay.

Operation from the Mains

Mains-operated controllers must produce output pulses similar in characteristics to those given by battery-operated types, and to that extent there are broad similarities between the two groups. However, supply from the mains introduces additional design complications since it is imperative to ensure that the mains voltage can never in any circumstances appear on the fence wire. Sound mechanical and electrical design, to some extent imposed and regulated by stringent national and international standards, can prevent this happening due to component failure or mechanical faults within the fencer. There are certain contingencies, however, in which careful design of the controller can be no safeguard.

It must be recognized that a mains-operated controller is as safe as its method of installation. It should be mounted where there is no likelihood of mechanical damage, and there must be no possibility of the fence wire coming into contact with a power lead. If reasonable care is taken over these points, a mains-operated controller is as free from danger as a battery-operated type.

The methods of operation of mains fencers can vary even more widely than with battery-operated units. Some types apply short, high-voltage 50 c/s pulses to the fence through a transformer of high-leakage reactance. The short pulses, of 50-60 millisec duration, are provided by an ingenious mercury interrupter actuated by the thermal expansion and contraction of a gas volume heated transiently by a filament.

One manufacturer employs an entirely electronic circuit which is fundamentally identical with the capacitive discharge circuit shown in Fig. 2. In this modification a rectifier produces the d.c. supply to charge the capacitor, which is discharged through the output transformer by means of a small thyratron. The thyratron is triggered at regular 1 sec intervals by pulses from a blocking oscillator.

Neither of the above forms of circuit is common in this country. The two controllers that are perhaps most likely to be met are both capacitive discharge types, partly mechanical in operation, but differing in the way in which the discharge is controlled.

Type 1.—The circuit of this controller is shown in Fig. 3. The reservoir capacitor C_1 is charged with direct current by means of the half-wave selenium rectifier Re, and the smoothing circuit $C_2R_1R_2$. Each second it is discharged through the primary of the output transformer T by a mercury switch S, which is oscillated by a mechanism driven by a small, synchronous, clock-type motor M. The mercury switch is so designed that the contacts are closed for only a very short time as the mercury pool passes over them, and they can never be permanently shorted by the mercury.

Type 2.—The circuit of this controller is shown diagrammatically in Fig. 4. The circuit is basically the same as the capacitive discharge circuit of Fig. 2, but the Post Office relay is here replaced by a coil-and-armature contact system similar to that used in inductive discharge controllers. When the unit is switched on, the capacitor C is charged from the mains by way of the metal rectifier Re and the resistor R. The high initial current passing through coil A/1, which is wound on a magnetic core, deflects the spring-loaded armature and breaks the contact A1. Thereafter the capacitor is disconnected from the output transformer until the control hairspring returns the armature and A1 closes. The capacitor is then discharged through the output transformer primary, and the cycle is repeated. The resistor and capacitor R_1C_1 across the contacts are to limit sparking, while the air-cored chokes L_1 and L_2 prevent surge voltages being injected into the mains.

The question of fencer output limitation from the point of view of safety has already been mentioned. Other difficulties arise in considering the effectiveness of fencing units, since there seems to be little information on the

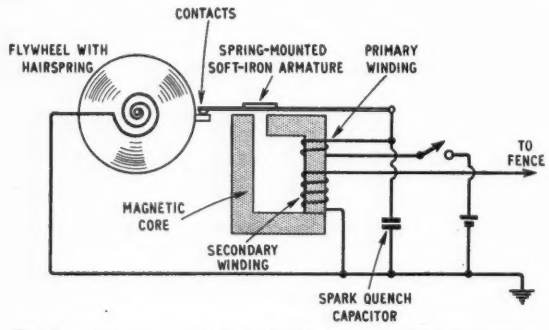


Fig. 1.—Arrangement of an inductive discharge battery-operated (6 V) controller

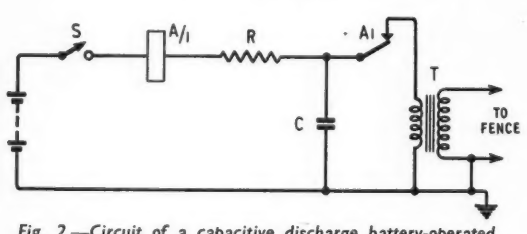


Fig. 2.—Circuit of a capacitive discharge battery-operated controller

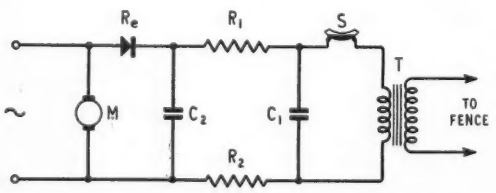


Fig. 3.—Circuit of a mains-operated controller using a mercury interrupter

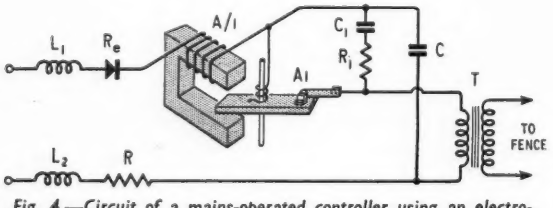
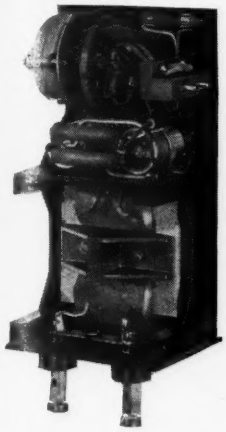
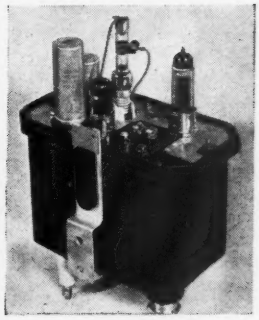


Fig. 4.—Circuit of a mains-operated controller using an electrochemical interrupter





An electronic mains-operated controller

Left: One type of mains-operated controller

particular characteristics of pulse voltages which influence the sensation of shock. It seems likely that the current flowing in the nervous system is responsible for the sensation, and since the equivalent circuit of the body consists of a capacitance and a resistance in parallel, it is possible that the rate of change of voltage in the pulse is an important factor. Such an effect is necessarily of short duration, and so will have little bearing on the danger to life from a certain pulse shape which is best assessed by the peak voltage and quantity of electricity criteria discussed earlier.

The wide range of output pulse shapes which give shock characteristics adequate for fencing livestock is shown in Fig. 5 for a few of the available types of fencer. The difficulty of making a comparison of effectiveness between the output pulses on purely electrical grounds is apparent.

All these output pulses are influenced in shape and magnitude by the load into which the fencer operates, which consists of a resistance in parallel with a capacitance. For an ideal fence, the effective load resistance is infinite, but in practice this state rarely obtains. Vegetation allowed to grow into contact with the wire, or insulator leakage, caused by moisture, dirt or mechanical damage, both reduce the load resistance. The minimum value may be the 500 ohms required by specifications. The load capacitance results from the proximity of the fence to the ground and is easily estimated. For a fence constructed of 16 s.w.g. wire at a height of 30in it is about 0·012 μF per mile.

Performance

In assessing the effect of load on the performance of any one fencer the peak output voltage can be taken as a general criterion. A typical family of curves relating peak output voltage and effective load resistance and capacitance for one type of battery-operated controller is shown in Fig. 6. The general shape of these curves is common to all controllers. It can be seen that reduction of the load resistance and increase in the length of fence causes the output of the fencer to fall and so reduces its effectiveness. In some controllers, winding design is such that resonance occurs with small load capacitances, and the output voltage rises with increased fence length before falling. The deliberate introduction of this characteristic enables a longer fence to be excited effectively. Most battery-operated controllers can energize a fence of 3 to 5 miles of 16 s.w.g. wire at a height of 30in. Under the same conditions, mains-operated units can excite up to 10 miles of fence. For fences of more than one wire or reduced spacing to earth the length is correspondingly less. Fences of this length are not normally required in this country and may even be undesirable because of the difficulty of maintaining good insulation over long distances. The power requirements of mains-operated controllers, although small, vary considerably. Some require only 2 W at 230 V while others take up to 12 W, but the cost of power is probably insignificant in all cases. The output load makes little difference to the consumption.

Operating costs are less easy to assess for battery-operated controllers. Those types which use a 6 V accumulator draw a mean current of 15-20 mA in normal operation. For the type of controller in Fig. 1, the consumption is sharply dependent on the load resistance and is two to three times this value for a 500 ohm load. Poor fence wire insulation in this case not only causes inefficient fencing but also produces a heavy battery drain. Even with a knowledge of the consumption, it is difficult to predict the probable interval between charges in practice. Low-voltage accumulators for fencers are often not well maintained, so it is probable that many of them are operating at reduced efficiency. However, a 25 Ah battery in good condition should operate a controller for some six months.

Maintenance problems do not arise when the controller is energized by dry cells, since an exhausted battery is

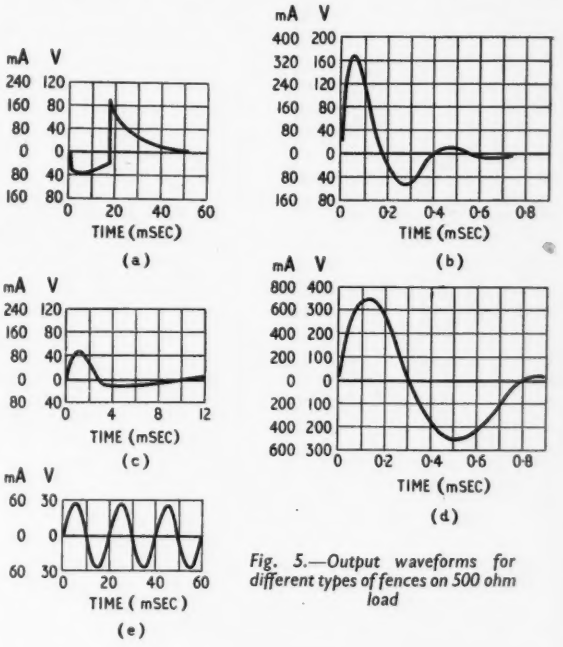


Fig. 5.—Output waveforms for different types of fences on 500 ohm load

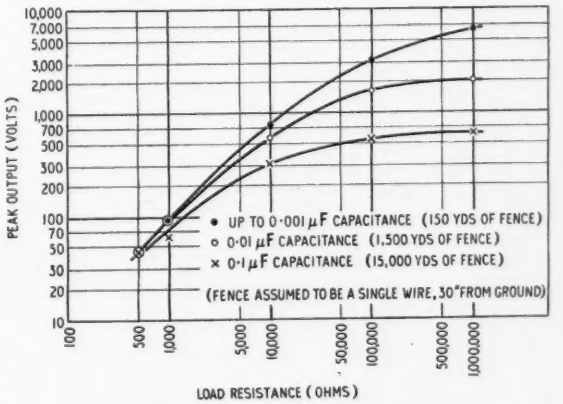


Fig. 6.—Output characteristics of a typical controller

replaced by a new one. The current consumption of a unit supplied by a high-tension radio battery is of the order of 1 mA. Battery life is uncertain at such low drain, but may be expected to be about three to four months. In comparing the running expenses for the two types of battery controller, the cost of new dry cells has to be set against the cost of recharging accumulators, and the difficulty which a farmer may find in maintaining them adequately.

The operating costs of mains-operated controllers are probably lower than for battery-operated types, and they require much less attention. The installation is much less flexible, however, and permanent wiring is necessary. This may not be a disadvantage when a considerable length of permanent fencing is to be installed near to farm buildings, but it reduces the operational flexibility of the electric fence which is one of its great advantages.

Electric fences and controllers can cause radio interference under certain conditions, for example if a discharge occurs in the high-voltage secondary circuit. Such a discharge may be caused by the fence wire being earthed by vegetation or an animal or by poor electrical insulation. A bad contact in the secondary circuit can also be responsible, as when a poor connection is made in the fence wire, or there is an open circuit in the secondary winding of the fencer output transformer. In the latter case the fencer will often continue to operate, but with serious interference. Sparking at contacts in the controller due to severe pitting or a faulty spark quench capacitor can also cause trouble by direct radiation. Mains-operated controllers may cause surges to be injected into the supply mains, but recent specifications limit the surge voltages to acceptable amounts.

The writer is indebted to many manufacturers of electric fence controllers for allowing him to examine and test their products. In particular he would like to thank Wolseley Engineering, Ltd., Fullwood & Bland, Ltd. and Philips Electrical, Ltd., for the provision of photographs. The Post Office Engineering Department kindly provided information on radio interference from fences and controllers.

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A British Standard for mains-operated fence controllers is being prepared.

Rhodesian Electricity

From a Salisbury Correspondent

WITH the publication on 6th January of the draft Electricity Bill, 1956, presented to the Federal Assembly early this year, it is now possible to visualize the organization designed for expanding electricity supplies throughout the Federation of Rhodesia and Nyasaland and controlling the output from the Kariba hydro-electric development scheme.

Broadly, the Act will provide for the setting up of a Federal Power Board; territorial Electricity Councils; and territorial Electricity Supply Commissions. Different parts of the Act can come into operation at different times and so there is no information yet available as to when the present Federal Hydro-Electric Board will be superseded by the Federal Power Board or when an Electricity Supply Commission will be set up in Northern Rhodesia or Nyasaland.

Probably the most important change will be the right given to the Federal Power Board to establish the undertaking for the supply of hydro-electric power by means of the waters of the Zambesi at the Kariba Gorge, and any other undertaking for the supply of hydro-electric power and the power to interconnect existing power stations and to purchase the total output of these stations. This Board is also given power to exercise such control as it may deem necessary over the output of electricity from generating stations which are interconnected with the main transmission lines.

The Federal Power Board will thus function in a manner very reminiscent of that of the British Central Electricity Board established under the Electricity (Supply) Act, 1926, and later superseded by the Central Electricity Authority.

The Electricity Councils which will be formed in each territory seem to be a compromise between the present Electricity Control Board of Southern Rhodesia, the Electricity Commission set up in Great Britain by the Electricity (Supply) Act, 1919, and the Consultative Councils created by the Electricity Act, 1947, in Great Britain. Their functions are purely advisory and they will assist the Minister in all matters affecting electricity in the individual territories. They appear to have no control over the Federal Power Board.

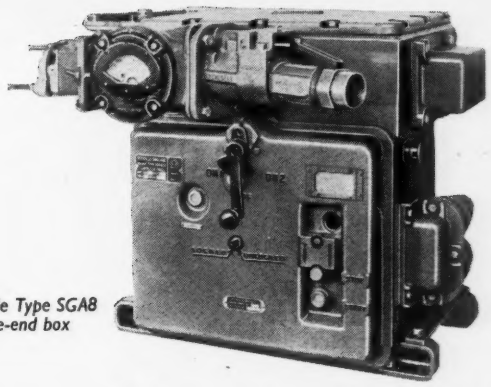
The Electricity Supply Commissions will develop along the lines already pursued by the Electricity Supply Commission of Southern Rhodesia which organization automatically becomes the Southern Rhodesia Electricity Supply Commission on the passing of the Act. This Commission has already set an extremely high standard in enterprise, development and technical skill, and can well be used when the time arises as a model for the other two Commissions to be formed.

The financial provisions provide that the Board and Commissions shall operate on a commercial basis and permit them to build up a general reserve fund the establishment or management of which can be determined by the Minister of Power.

Provision is also made for the Minister, subject to the money being voted by the Federal Legislature, to guarantee to pay the Board or a Commission an amount equal to the capitalized value of any loss which the Board or a Supply Commission may sustain through any extension of its transmission lines which has been carried out at the request of the Minister.

Apart from the provision for the control of operation of power stations it would appear that municipal supplies will in no way be affected. There appears to be little in the Bill likely to prove of a contentious nature and it is anticipated that it will be passed by the Federal Legislature without material amendment.

Newly Developed Gate-end Box



Reyrolle Type SGA8 gate-end box

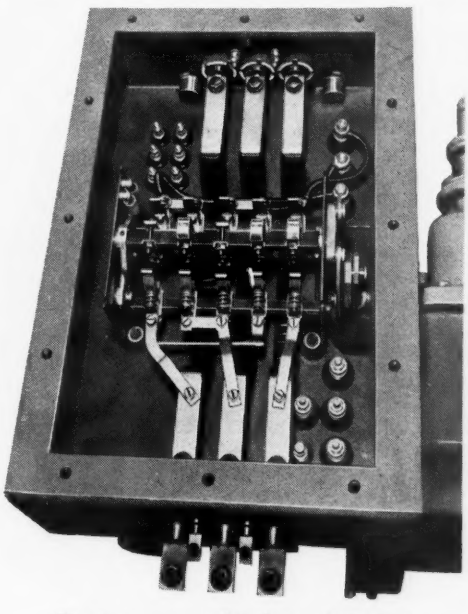
A NEW gate-end contactor unit complying with the National Coal Board Specification No. P3/1950 and designated Type SGA8 is now being manufactured by A. Reyrolle & Co., Ltd., and is the latest addition to their range of flameproof mining products.

The unit is suitable for the direct-starting of squirrel-cage motors associated with coal-cutters, conveyors, loaders, and the like and has a rating of 80 A at up to 650 V, 3 phase, 50 c/s. The design ensures ease of installation and maintenance, and facilitates extension to similar units.

The welded-steel case has two separate flameproof compartments, one above the other. The upper compartment accommodates the 300 A busbars and a triple-pole reversing isolator which is capable of breaking the normal current in emergency. The arrangement of this chamber is seen in the photograph. Access is obtained by removal of a bolted light-alloy cover. A framework carries the contactor together with control, protective, and auxiliary apparatus and can be drawn forward on rails for inspection and maintenance.

Over-current protection is provided by two series trip-coils with time-lag dashpots having a double-action characteristic to suit motor-starting conditions and earth-fault protection is provided by means of a ring-type core-balance transformer and a direct-acting relay having contacts in the contactor operating-coil circuit. The transformer is suitable for currents up to the full rating of the panel and tripping occurs with a primary fault current of 0·5 A. On operation, the relay latches out and a shrouded hexagon-headed screw in the front cover gives access to the relay for hand resetting. A shrouded push-button is provided on the front cover for checking operation of the earth-fault protection by injection testing.

Electrical lockout of the earth-fault protection can also be arranged when required. The lockout circuit, which is certified intrinsically safe, embraces the earth fault and is energized at 30 V from the voltage transformer. The circuit energizes the earth-fault relay which opens the contactor-coil circuit, trips the contactor, and prevents reclosure until the circuit is de-energized by removal of the fault. The lockout circuit also functions in the event of a fault occurring while the contactor is not energized and prevents closure on the fault.



The top cover removed to show contactor gear

The type SGA8 unit is normally remote controlled with pilot-core protection provided by an intrinsically-safe circuit which inherently ensures continuity of the earth-circuit. The contactor will not close, and if already closed will open, in the event of the trailing cable and/or operating pilot-cable developing a short-circuit between pilot and earth cores or a break in the earth or pilot cores. The trailing-cable plugs are thereby electrically interlocked since their withdrawal is equivalent to a break in the pilot and earth-return circuits. The intrinsically-safe circuit, which is generally similar to that designed in conjunction with the National Coal Board, relies upon uni-directional rectified alternating current and includes a pilot relay having a closed secondary circuit on the operating-magnet system. A 15 ohm resistor mounted remotely with the rectifier is inserted in the pilot circuit after the contactor has been closed by earthing the pilot circuit through the half-wave rectifier. The current in the pilot circuit is thus limited to a value which will hold the relay in position but will not allow it to pick up should the contactor trip on the failure and subsequent restoration of supply.

With this control arrangement, a short-circuit in the pilot circuit cuts out the half-wave rectifier located at the remote-control point and energizes the pilot relay with alternating current. Under this condition the closed secondary circuit effectively de-magnetizes the relay so that it does not operate. Similarly, the pilot relay, being de-energized, does not operate with a break in the pilot circuit. Thus, with either type of fault, the pilot relay, by failing to operate, breaks the contactor operating-coil circuit, tripping the contactor if closed, and preventing operation if open.

Incoming or straight-through cable arrangements can be provided by means of standard trifurcating boxes or flit-plugs fitted to the ends of the busbar chamber. Busbar-chamber ends without such fittings or trunks to other equipment are fitted with domed end-caps. An outgoing 100 A 4-pin B.S. plug and socket is mounted on the front of the unit and provision is made on the socket bend for a direct-connected ammeter. A pilot-cable box for up to four cables can be provided on the right-hand end of the unit.

Human Relations in Industry

A booklet suggesting methods of improving relations between employers and employees has been published by Aims of Industry, Ltd., 12, Carteret Street, Westminster, London, S.W.1, price 2s 6d. In a letter sent with each booklet Sir George Earle, president of the Council of Aims of Industry, says that much industrial unrest is caused by lack of knowledge among workers generally. He urges that all employers should try to overcome this by supplying workers with factual information about their own firms and encouraging them to ask for it.

Domestic Electrical Equipment

Electric Irons

AN electric iron is now accepted as being an almost indispensable item of home laundry equipment and altogether there are about thirty different makes from which to make a choice.

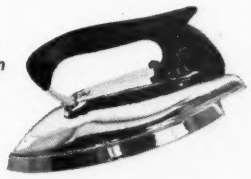
Automatic models which incorporate a thermostat to give regulated heating and, in most cases, a pilot light to indicate when the current is on, are the irons most in demand and in addition these have the added advantage of lower electricity consumption, thus reducing ironing costs. Many of the manufacturers, however, also include the less expensive or non-automatic type in their respective ranges.

Modern electric irons are attractive items of domestic equipment with their chromium, coloured or anodized finishes, moulded handles and streamlined shapes, and provided they are well treated should give years of trouble-free service. Special lightweight irons, incorporating fold-flat handles and universal voltage ranges, are designed for the traveller, some weighing only little more than 1 lb. Besides eliminating the need for damping down articles before ironing, the steam iron can also be used as an ordinary iron. The number of makers of this type of iron still remains at three, namely, Hoover, Morphy-Richards and Kenwood Electrics.

With few exceptions, the prices are unchanged since we reviewed irons twelve months ago, but it must be remembered that the electric iron is now subject to purchase tax in the United Kingdom at the rate of 30 per cent.

Manufacturer	Name or Model	Type	Weight	Loading	Special Features	Finish	Price (Excl. Tax)	Purchase Tax
A.B. METAL PRODUCTS, LTD., Ynysboeth, Abercynon, Glamorgan.	" Clem "	Travelling	1½ lb	80 W	Universal voltage	Anodized body, chromium sole plate	£1 15 0	£0 7 10
BYLOCK ELECTRIC, LTD., South Street, Enfield, Middlesex.	" Victor "	Automatic, tilting safety	5 lb	750 W	Left or right handed	Pastel-primrose, blue or green	£3 2 6	£0 13 9
CARRON CO., Carron, Falkirk, Stirlingshire.	" Carron "	Non-Automatic	5 lb	450 W	—	Nickel plated	£1 1 6	£0 4 9
CO-OPERATIVE WHOLESALE SOCIETY, LTD., National Works, Hall Street, Dudley.	" Senior "	Automatic	4½ lb	800 W	—	Chromium	£2 5 0	£0 10 1
	" Major "	Non-Automatic	5½ lb	550 W	—	Chromium	£1 13 6	£0 7 6
	" Minor "	Non-Automatic	4½ lb	450 W	—	Chromium	£1 2 0	£0 5 0
EASIPOWER, LTD., 213-215, Gloucester Place, London, N.W.1.	" 100/D "	Automatic	5 lb	600 W	Illuminated control knob in handle	Chromium or vitreous enamel	£2 5 0	£0 9 11
	" 99 "	Automatic	3½ lb	600 W	Illuminated control knob in handle	Cream or primrose vitreous enamel	£2 2 6	£0 9 4
	" 99U "	Automatic	3½ lb	600 W	Illuminated control knob in handle, a.c./d.c.	Cream or primrose vitreous enamel	£2 5 0	£0 9 11
ELGA PRODUCTS, LTD., Railway Place, Wimbledon, S.W.19.	" Gadabout "	Travelling	1½ lb	300 W	Fold flat handle	Chromium (*a*) or coloured enamel (*b*)	£2 2 0 (*a*) £1 19 6 (*b*)	£0 9 3 (*a*) £0 8 8 (*b*)
FALK, STADELMANN & CO., LTD., 91, Farringdon Road, London, E.C.1.	" Featherlight " 95659	Automatic	3 lb	750 W	Left or right handed, button contour	Chromium	£1 19 6	£0 8 8
	" Pilot " 95707	Automatic	4½ lb	450 W	Left or right handed, pilot light	Chromium	£2 2 0	£0 9 2
	" Standard " 95669	Non-Automatic	4½ lb	450 W	Left or right handed	Chromium	£1 8 6	£0 6 0
	" Gadabout " 95636	Travelling	1½ lb	300 W	Fold flat handle	Chromium	£2 2 0	£0 9 0
GENERAL ELECTRIC CO., LTD., Magnet House, Kingsway, London, W.C.2.	" Bride's Iron " D.5850 C.P.	Automatic	2¾ lb	750 W	Lightweight, snap-action thermostat	Chromium	£2 2 6	£0 9 4
	" Bride's Iron " D.5850	Automatic	3¼ lb	750 W	Lightweight, snap-action thermostat	Cream vitreous enamel	£2 5 0	£0 9 10
	D.5805	Standard	5 lb	450 W	Streamlined	Chromium	£1 12 6	£0 7 2
	D.5827	Travelling	3 lb	300 W	Fold flat handle, universal voltage	Chromium	£2 15 0	£0 12 1

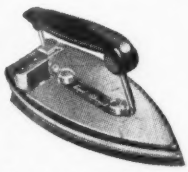
Manufacturer	Name or Model	Type	Weight	Loading	Special Features	Finish	Price (Excl. Tax)	Purchase Tax
GRAFTON HEATER CO., LTD., 13-15, Westland Place, London, N.1.	DD1	Automatic	5 lb	750 W	Left or right handed, a.c. (a) a.c./d.c. (b)	Stoved enamel	£1 17 6 (a) £2 2 6 (b)	£0 8 6 (a) £0 9 4 (b)
	DD2	Automatic	5 lb	750 W	Left or right handed, a.c. (a) a.c./d.c. (b)	Chromium	£2 2 6 (a) £2 5 0 (b)	£0 9 4 (a) £0 9 11 (b)
L. G. HAWKINS & CO., LTD., 30-35, Drury Lane, Kingsway, W.C.2.	"Universal" L.G.H.1220	Automatic	4½ lb	800 W	Dial controls include on/off switch	Black or cherry handle, chromium body	£2 9 6	£0 10 10
H.M.V. HOUSEHOLD APPLIANCES, Hayes, Middlesex.	"Milady's Iron"	Automatic	4 lb	750 W	Left or right handed, pilot light	Primrose vitreous enamel	£1 19 9 £2 3 0 (a.c./d.c.)	£0 8 9 £0 9 6 (a.c./d.c.)
HOMEFYRE, LTD., 66-72, Brewery Road, London, N.7.	160T	Automatic	4½ lb	650 W	Left or right handed	Chromium, nickel or coloured	On application	
	160A	Non-Automatic	4½ lb	450 W	Left or right handed	Chromium, nickel or coloured	On application	
	M1000	Non-Automatic	3 lb	450 W	Lightweight connectorless	Chromium, nickel or coloured	On application	
HOOVER, LTD., Perivale, Greenford, Middlesex.	"Steam-or-Dry"	Automatic	3½ lb (dry) 4 lb (filled)	1 kW	Left or right handed	Chromium with brown plastic dial control and handle	£4 19 6	£1 2 6



L. G. Hawkins "Universal" iron

A.B. Metal Products "Clem" travelling iron

Grafton automatic

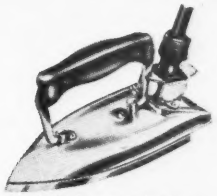


Elga Products "Gadabout" travel iron

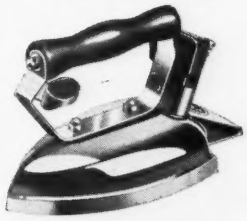
Left : Easipower automatic

Left : Bylock "Victor" safety iron

G.E.C. "Bride's" iron



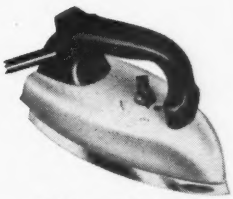
G.E.C. travelling iron



Below : Carron non-automatic iron

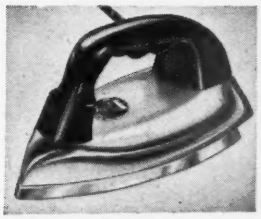
Hoover "Steam-or-Dry" iron

H.M.V. "Milady's" iron



Falk's "Featherlight" automatic

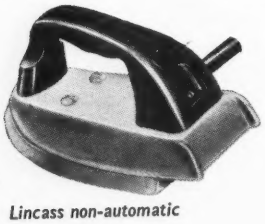
Below : C.W.S. "Senior" automatic iron



Homefyre "160T" automatic iron

ELECTRIC IRONS . . . . . *continued*

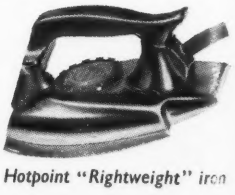
Manufacturer	Name or Model	Type	Weight	Loading	Special Features	Finish	Price (Excl. Tax)	Purchase Tax
THE HOTPOINT ELECTRIC APPLIANCE CO., LTD., Crown House, Aldwych, W.C.2.	" Plus Five "	Automatic	6 lb	800 W	Swivelling flex, left or right handed, button contours	Chromium	£3 15 0	£0 16 5
	" Rightweight "	Automatic	3¾ lb	800 W	Swivelling flex, left or right handed, button contours	Chromium	£3 5 0	£0 14 3
JELSON ELECTRIC, LTD. Spring Road, Tyseley, Birmingham, 11.	MX20	Automatic	4¼ lb	800 W	—	Chromium	£2 5 0	£0 9 11
KENWOOD ELECTRICS, LTD., 26, North Audley Street, London, W.1.	" Steam-o-matic "	Steam or dry	3½ lb (dry) 4 lb (filled)	1 kW	Stainless steel construction	Polished stainless steel	£5 7 6	£1 3 7
LINCASS ELECTRIC, LTD., White Hart Yard, Guildford Street, Chertsey, Surrey.	134 and 144 (a.c./d.c.)	Non-Automatic	4½ lb	450 W	Left and right handed	Coloured (134) and chromium (144)	£1 5 6 (134) £1 7 6 (144)	£0 5 7 (134) £0 6 0 (144)
	434P and 444P	Automatic	4½ lb	750 W	Pancake selector dial, left and right handed, pilot light	Coloured (434P) Chromium (444P)	£1 19 6 (434P) £2 2 6 (444P)	£0 8 7 (434P) £0 9 4 (444P)
	436P (a.c./d.c.) and 446P (a.c./d.c.)	Automatic	4½ lb	750 W	Pancake selector dial, left and right handed, pilot light	Coloured (436P) Chromium (446P)	£2 2 6 (436P) £2 5 6 (446P)	£0 9 4 (436P) £0 9 10 (446P)
	444PH	Automatic	6 lb	750 W	Pancake selector dial, left and right handed, pilot light	Chromium	£2 7 6	£0 10 3
	444PHS and 446 PHS (a.c./d.c.)	Automatic	7 lb	1 kW	Pancake selector dial, left and right handed, pilot light	Chromium	£2 12 6 (444 PHS) £2 17 6 (446 PHS)	£0 11 5 (444 PHS) £0 12 6 (446 PHS)
LUCAS HOLDER, LTD., 25, Allesley Old Road, Coventry.	" Smoothie " Standard	Travelling	1¾ lb	75 W	100/150 or 200/250 V ranges, zip leather cases available	Chromium	£1 8 0	£0 6 4
	" Smoothie " Universal	Travelling	1¾ lb	75 W	100 to 250 V changeover switch, zip leather cases available	Chromium	£1 12 6	£0 7 4
METWAY ELECTRICAL INDUSTRIES, LTD., Canning Street, Kemp Town, Brighton, 7.	DA224 (*a*) DA226 (*b*) and DA225 (*c*)	Non-Automatic	5 lb	450 W	Nickel sole plate	Coloured (*a*), nickel (*b*) and chromium (*c*)	£1 2 4 (*a*) £1 2 9 (*b*) £1 5 0 (*c*)	£0 4 10 (*a*) £0 4 11 (*b*) £0 5 5 (*c*)
	DA439 (*a*) and DA446 (*b*)	Automatic	4½ lb	700 W	Chromium sole plate	Coloured (*a*) and chromium (*b*)	£2 3 9 (*a*) £2 4 6 (*b*)	£0 9 6 (*a*) £0 9 7 (*b*)
	DA186	Travelling	2 lb	150 W	Nickel sole plate	Nickel or coloured	£0 18 6	£0 4 0



Lincass non-automatic

Lincass "444P" automatic

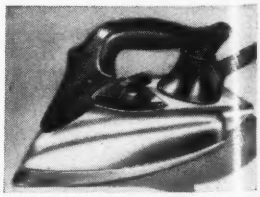
Lucas Holder "Smoothie" travelling iron



Hotpoint "Rightweight" iron

Metway automatic iron

Metway travel iron



Hotpoint "Plus Five"

Premier "Super-Smoothwell"

Jelson "MX20" automatic iron

Morphy-Richards steam iron

Premier "Nine-o-Nine"

Kenwood's "Steam-o-Matic"

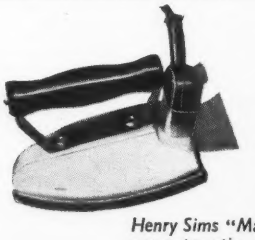
Mysto-Maid "Popular" 992

Manufacturer	Name or Model	Type	Weight	Loading	Special Features	Finish	Price (Excl. Tax)	Purchase Tax
MORPHY-RICHARDS, LTD., 6, Conduit Street, London, W.1.	"Senior" CA/75	Automatic	4½ lb	750 W	Pilot light, thermostatic control	Primrose, blue or green (*a*) and chromium (*b*)	£1 19 6 (*a*) £2 5 0 (*b*)	£0 8 7 (*a*) £0 9 9 (*b*)
	"Senior" CU/75	Automatic	4½ lb	750 W	Pilot light, thermostatic control, a.c./d.c.	Primrose, blue or green (*a*) and chromium (*b*)	£2 4 6 (*a*) £2 10 0 (*b*)	£0 9 8 (*a*) £0 10 10 (*b*)
	"Senior" PA/75	Automatic	4½ lb	750 W	Pilot light, thermostatic control	Coloured porcelain body	£2 5 0	£0 9 9
	"Senior" PU/75	Automatic	4½ lb	750 W	Pilot light, thermostatic control, a.c./d.c.	Coloured porcelain body	£2 10 0	£0 10 10
	"Atlantic" LA/75	Automatic	2¾ lb	750 W	Pilot light, thermostatic control, reversible flex	Primrose, blue or green (*a*) and chromium (*b*)	£1 19 6 (*a*) £2 5 0 (*b*)	£0 8 7 (*a*) £0 9 9 (*b*)
	"Atlantic" LU/75	Automatic	2¾ lb	750 W	Pilot light, thermostatic control, reversible flex, a.c./d.c.	Primrose, blue or green (*a*) and chromium (*b*)	£2 4 6 (*a*) £2 10 0 (*b*)	£0 9 8 (*a*) £0 10 10 (*b*)
	"Power" AP/10	Automatic	6½ lb	750 W	Heavy duty	Chromium	£2 12 6	£0 11 5
	"Power" UP/10	Automatic	6½ lb	750 W	Heavy duty a.c./d.c.	Chromium	£2 17 6	£0 12 6
	"Steam-or-Dry" ZA/75	Automatic	3 lb (dry) 3¼ lb (filled)	750 W	Pilot light, reversible flex	Chromium	£2 19 6	£0 12 11
	"Steam-or-Dry" ZU/75	Automatic	3 lb (dry) 3¼ lb (filled)	750 W	Pilot light, reversible flex, a.c./d.c.	Chromium	£3 5 0	£0 14 1
MYSTO-MAID ELECTRICAL APPLIANCES, Parkfield Road, Saltley, Birmingham, 8.	"Popular" 992	Non-Automatic	4½ lb	450 W	Left or right handed	Nickel plated	£1 6 6	£0 5 10
	"Thermo" 994	Automatic	5½ lb	650 W	Left or right handed, pilot light	Chromium	£2 10 0	£0 11 0
PIFCO, LTD., 36-37, Upper Thames Street, London, E.C.4.	"Pifco" 1042	Automatic	5 lb	750 W	Streamlined, built-in pilot light	Chromium	£2 4 11	£0 9 10
PREMIER ELECTRIC HEATERS, LTD., Keeley Street, Birmingham, 9.	"Super-Smoothwell" 835	Automatic	5 lb	750 W	Pilot light, snap-action thermostat	Chromium	£2 5 0	£0 9 11
	"Nine-o-Nine" 909	Automatic	5 lb	1 kW and 800W	Left or right handed, light in front of handle	Chromium	£4 2 6	£0 18 2
	"Sylph" 861	Automatic	3¼ lb	1 kW and 800 W	Encased element, quick heating	Chromium	£2 19 6	£0 13 1
	"Smoothwell" 814	Non-Automatic	4¾ lb	650 W	Hard-wearing	Chromium	£1 8 6	£0 6 4

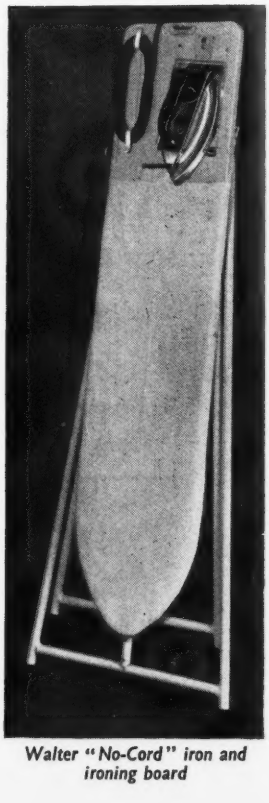
ELECTRIC IRONS . . . . . *continued*

Manufacturer	Name or Model	Type	Weight	Loading	Special Features	Finish	Price (Excl. Tax)	Purchase Tax
REVO ELECTRIC CO., LTD., Tipton, Staffs.	"Automatic"	Automatic	4¼ lb	650 W	Left and right handed pilot light	Chromium	£2 5 0	£0 9 11
ROBSON ELECTRICAL PRODUCTS, LTD., Ultralite Works, Union Street, West Bromwich.	"Explorer"	Non-Automatic	5 lb	450 W	—	Coloured or nickel plated	£0 19 6	£0 4 5
	"Ultralite"	Non-Automatic	5 lb	450 W	—	Chromium	£1 3 0	£0 5 2
	"Roblec"	Automatic	4½ lb	700 W	—	Coloured or nickel plated	£1 13 9	£0 7 7
	"Roblec"	Automatic	4½ lb	700 W	Pilot light	Chromium	£1 19 6	£0 9 0
	"Roblec Junior"	Travelling	2 lb	200 W	—	Coloured	£0 15 6	£0 3 6
SELEX ELECTRIC CO. (KIRKBY), LTD., Yardley Road, Kirkby Industrial Estate, Liverpool.	"Xcel" A.2004	Non-Automatic	5 lb	450 W	Left or right handed, reversible flex	Chromium	£1 9 6	£0 6 6
HENRY SIMS, 191, Goldhurst Terrace, London, N.W.6.	"Simfold"	Travelling	2½ lb	300 W	Fold-flat handle	Chromium	£1 19 9	£0 8 8
	"Simfold" Universal	Travelling	2½ lb	300 W	Fold-flat handle, 110–250 V range	Chromium	£2 9 6	£0 10 10
	"Mavec"	Non-Automatic	4½ lb	450 W	200/250 or 110/120 V	Cream, blue or light green	£0 15 9	£0 3 7
TYM'S ELECTRIC, LTD., Systym Works, Kennard Road, Stratford, E.15.	"Golden Arrow"	Automatic	5½ lb	750 W	—	Coloured body, chromium sole plate	£1 17 6	£0 8 6
	"Silver Arrow"	Automatic	5½ lb	750 W	—	All chromium	£2 1 0	£0 10 0
	"Streamline Safety"	Non-Automatic	4 lb	450 W	—	All chromium	£0 18 6	£0 4 3
J. & H. WALTER, LTD., 27, Craven Street, London, W.C.2.	"Walter No-Cord"	Automatic	5 lb	900 W	Cordless and complete with ironing table	Cream	£9 17 6	£2 2 3
F. WESTERMAN (WHOLESALE), LTD., 94, Dale End, Birmingham, 4.	"Welec Glide-Eesi"	Non-Automatic	4 lb	450 W	Streamlined	Nickel plated	£0 19 9	£0 4 3

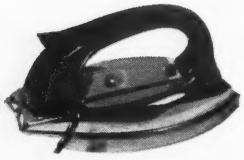
Henry Sims "Simfold" travelling iron



Henry Sims "Mavec" non-automatic



Walter "No-Cord" iron and ironing board



Left : Westerman "Welec Glide-Eesi"

Revo "Automatic"

Robson "Explorer" non-automatic

Robson "Roblec" iron

Engineering in Europe

ABSTRACTS FROM FOREIGN TECHNICAL JOURNALS

THE excellent dielectric, mechanical and chemical characteristics of impregnated paper insulation are partly offset by its hygroscopicity, which is of a very peculiar type. The water absorption of paper is not proportional to the relative moisture content of the surroundings, but may even exceed it and depends strongly on the kind of paper and on the ambient temperature. It should be noted that the usual impregnants, above all, oil, do not really alter the final equilibrium conditions between moisture in the surroundings and the paper, but only retard their establishment. An intrinsically different effect is achieved by acetylation of the paper, since this results in a structural change of the cellulose by which the hydroxyl groups, which are mainly responsible for the hydration of the paper, are " blocked " or, more correctly, replaced by acetyl groups. The latter cannot form " hydrogen bridges " and thus the absorptivity of the cellulose is reduced, according to the degree of acetylation.

The improvement of the insulation resistance by the reduced water absorption is very marked, and it is paralleled by an improved temperature relation of the dielectric loss factor, although this is probably not only due to the reduction of the moisture content. A further important fact is that an impregnation of acetylated paper by chlorinated oils of high dielectric constant leads to an optimum field distribution in the insulation. The relations between breakdown voltage and density of the material, the dielectric characteristics of acetylated and impregnated papers under thermal and electric stresses and the improved ageing properties are thoroughly discussed and many examples of successful applications of the new insulating material are given.—" Acetylated Paper as an Insulating Material in Electrical Engineering," W. Dieterle, *A.S.E. Bull.*, Vol. 46, No. 22, pp. 1045-1065, 29th October, 1955, in German.

Moisture in Transformers

The methods of determining the moisture content of transformer insulation are important, particularly in assessing the possibility of taking transformers into service without preliminary drying. The U.S.S.R. power systems use a combination of the following methods: measurement of the insulation resistance in relation to moisture absorption by megohmmeters and measurement of leakage currents with rectified voltage; tan δ measurements; capacitance measurements at two frequencies; oil tests. The suitability of these methods for the purpose is demonstrated by results obtained during many years' experience. The temperature of the dielectric losses of the transformer insulation for dry, moderately humid and very moist conditions was determined and expressed as a practical temperature factor of the dielectric losses, represented by the ratio of the losses at 70 deg C to those at 20 deg C.

The data obtained by measurements during long service periods are compared with those established by official standards and makers' instructions. This shows that the latter especially are often at variance with practical experience, as are also the indirect methods of determining moisture recommended by them. In particular, the general stipulation that transformers may be taken into service without drying only after a preliminary heat run, whatever the result of the moisture tests, is quite unjustified.—" Experimental Data on the Determination of Moisture in Transformers," M. V. Khomyakov, *Elektrichestvo,* No. 10, pp. 24-28, 1955, in Russian.

High-Speed Circuit-Breaking

High-speed circuit-breaking is particularly important in d.c. heavy-current operation, since short-circuit currents in d.c. systems may reach much larger values, being only controlled by the active resistances in circuit. Also, the powerful d.c. installations of the chemical industry, heavy d.c. drives, traction systems, etc., are mostly supplied by many generators in parallel, so that the ratio of total short circuit of the plant to the rated current of a single generator may be very large. Not only the d.c. installations, but also the a.c. supply systems must be protected by high-speed breakers.

The idea of using detonators in switchgear for rapid tripping has been developed for some years and has the following characteristics; the detonator not only starts the operation of the circuit-breaker mechanism, but also produces a high initial acceleration of the elements of this mechanism, thus reducing the time interval between the electric pulse detonating the charge and the breaking current to about 1 millisec. If a further reduction of this time is required, an even simpler way is to insert what might be called a detonator cut-out, i.e. a detonator destroying a length of conductor of the circuit. In this way the time between tripping pulse and current maximum may be reduced to 0·2-0·3 millisec, i.e. shorter by a full order of magnitude than the optimum achievable by other means. The switchgear designed on this principle has a rating of 12 kA and several kV and an almost unlimited breaking capacity for short-circuit currents, i.e. the latter are interrupted during the initial part of their rise.—" Heavy-Current Switchgear with Detonators for High-Speed Circuit-Breaking," E. Marx and L. Schmitz, *E.T.Z.(A)*, Vol. 76, No. 21, pp. 765-769, 1st November, 1955, in German.

380 V Insulation Supervision

The well-known methods of measuring the insulation resistance of systems with an insulated neutral by a recording instrument are satisfactory for scientific investigations, but not suitable for a permanent check of the insulation of installations, the condition of which is closely connected with the safety of operation of the plant it supplies and even with the health and life of its personnel. This applies above all to electrical installations in mines and other industrial plants where explosion dangers exist. The authors describe a set-up and recording instrument for continuous automatic supervision of the insulation resistance of such a system, based on the superposition of d.c. on the operating alternating voltage without interruption of the operation of the system. The indicating instrument consists of an iron-cored reactor, load resistance, an electromagnetic control relay and a kilo-ohmmeter, and gets its d.c. supply from the secondary winding of the system transformer through a selenium rectifier. The circuit is closed through the earthed

Readers who require accurate full translations of any of the articles abstracted in this section can be put into touch with the translators who will supply them at current rates.—Editors, *Electrical Review.*

metal casing of the instrument, i.e. through the insulation resistance of the three phases of the installation, and the d.c. in the circuit is determined by the resistances of the three phases in parallel. When the insulation resistance falls below the permissible minimum value, the relay actuates a chronometric device recording the operating time with reduced insulation resistance, and also a signalling relay. The paper reports surprisingly good figures for the maintenance of the insulation levels since the introduction of this supervision system in a coalmine, a mechanical engineering works and a building materials plant.—" Automatic Supervision of the Insulation of 380 V Installations," N. V. Olekhnovich and V. K. Yasnyi, *Elektrichestvo*, No. 10, pp. 57-59, 1955, in Russian.

H.V. Power Factor Correction

The problem of the economics of power-factor compensation has often been considered and many different schools of thought exist. However, there are some outstanding facts generally agreed upon, the most fundamental of which is that a static capacitor installation should at least pay for its installation, maintenance and operation. The forms in which the expenses come back vary, mainly as a reduction in the power losses, improvement of voltage stability, and also as a stress relief (or " reinforcement ") of the lines, viz. increase of transmitting capacity.

Consideration of all these aspects complicates an overall treatment of the problem. For this reason the author deliberately confines himself to determining the optimum economic degree of compensation for a given transmission system, and only from the viewpoint of loss reduction. The calculations are carried out for a system loaded only at the receiving end and for a system with a uniformly distributed load. The additional improvements mentioned above are not considered and therefore the results obtained have a conservative bias. They are given as annual savings per ampere current loading. The theoretical results are then applied to three classes of existing transmission systems; Class I (small load, compensation at sending end, where VAr can be consumed) economic compensation factor 0·8-0·85; Class II (many branch lines, large load at far end) compensation 0·85-0·95 at far end; Class III (load at far end) compensation 0·95, partly at near and partly at far end.—" The Problem of the Economic Power-Factor Compensation in H.V. Systems," B. Pavlovsky, *Elektrotech. Obzor*, Vol. 44, No. 11, pp. 563-569, 1955, in Czech.

Life of Electrical Machines

Just as the physiological age of a man, and thus his life expectation, depends on the condition of his blood vessels, that of an electrical machine depends on the state of its insulation. The essential difference, however, is that the life expectation of the machine can be increased by providing it with a more elaborate insulation to resist better the electrical, thermal and mechanical stresses and, possibly, chemical influences, to which it may be subjected in service.

The effect of thermal stresses on insulating materials is well known and has been thoroughly investigated, and some empirical relations (e.g. Montsinger's law) enable fairly reliable predictions to be made for the service life of the machine insulation merely from the aspect of the maximum temperatures permitted in operation. It is much more difficult to assess the " loss of life expectation " by mechanical influences (strictly speaking, only part of these are of a kind conventionally referred to as " stresses "), since they may take the form of rubbing, scratching and scoring, sometimes crinkling and are mainly due to thermal expansion of materials with widely differing expansion coefficients, mutual displacement of adjacent insulated conductors and vibrations during transient processes, etc.

Chemical influences are mainly due to glow discharges set up in small air occlusions in the insulation in which ozone is formed which attacks organic materials. A certain moisture content of the insulation may then cause nitrous acid to be formed which not only slowly destroys the insulation, but even corrodes conductor materials as well. A simple device for testing the effects of combined electrical, thermal and mechanical stresses on insulated wires is described which enables the service life of the insulation to be predicted, considering not only thermal and electrical stresses, but also mechanical wear.—" Contribution to the Determination of the Expectation of Life of Electrical Machines," J. Schroeder, *E.T.Z.(B)*, Vol. 7, No. 11, pp. 409-411, 21st November, 1955, in German.

Transformer Stresses

In the design of transformers with sandwich coils it is usual to consider only the axial mechanical forces and to neglect the radial forces, since they are much smaller than the former. However, this cannot always be taken for granted, especially when the influence of the core is considered, which may result (even with symmetrical coil arrangements) in alternating compressive and tensile stressing of the windings, depending on the size of the coils and their distance from the iron core. On the other hand, there are methods of design by which these mechanical forces can be compensated. A simple theoretical treatment of the problem introduces a report on comprehensive experimental investigations carried out on models and yielding relations between the leakage reactance and the spacing coil-core. According to these, the influence of the core material increases with the perimeter of the coils. A theoretical appendix presents an approximation method for determining leakage reactances.—" Radial Stresses in Transformers with Sandwich Coils," L. Merigliano, *Energia Elett.*, Vol. 32, No. 9, pp. 773-781, September, 1955, in Italian.

Semi-conductor Rectifiers

The advantages of distance protection equipment using rectifiers and polarized relays are well known; they include the possibility of obtaining various types of response characteristics of the relays (linear, circular, elliptic, hyperbolic) improved sensitivity and reduced power consumption of the relays compared with equipment using relays with linear elements. It is only due to the use of inappropriate methods of compensating the non-linearity of the VA-characteristics of the rectifiers that some of the distance relays of this type now used are actually affected by greater losses and do not achieve the possible sensitivity. Another disadvantage of these imperfect designs is that special smoothing devices have to be used for the rectified current to prevent relay vibrations, and that these slow down the response of the relay or, at least, introduce complications into the design.

Among the possible methods of compensation investigated in the paper, the best is without any doubt the use of a biasing e.m.f. which increases the efficiency of the protection by a factor 6-7 above that achievable with other methods of compensation (up to 60-70 per cent). The use of a biasing e.m.f. reduces the operating current of the protection system by a factor 2·5-3, which is very important for long and heavily loaded lines. No distortion of the response characteristics of the relays is introduced by this method of compensation.—" Compensation for the Non-Linearity of Semi-conductor-Type Rectifiers in Distance Relays," G. G. Gimoyan, *Elektrichestvo*, No. 11, pp. 69-74, 1955, in Russian.

NEW ELECTRICAL EQUIPMENT

Remote Control Switch

The GENERAL ELECTRIC CO., LTD., Magnet House, Kingsway, London, W.C.2, has developed a particularly compact and robust control switch in conjunction with Messrs. McLellan & Partners.

The switches can be mounted at $1\frac{5}{32}$ in centres horizontally and 6in vertically and are secured to panels by two fixing screws which are themselves drilled and tapped to take the fixing screws for the nameplate. Up to 180 such master switches can be arranged within easy reach of an operator when seated.

The switch is designed for a continuous rating of 20 A and is capable of breaking an alternating current of 30 A at 240 V. On 220 V d.c. the switch will safely interrupt 1 A on an inductive circuit and 2·5 A on a pure resistance circuit.

The switch consists of two main components—the switch body and the removable switch assembly. The body is moulded in two halves which are sealed and riveted together so that maximum protection is afforded against dust and moisture. Silver-faced fixed contacts and the heavy duty terminal screws are integral with the switch body so that wiring may be made permanent.

The removable switch assembly is of the plug-in type with phosphor bronze spring contacts. It can readily be withdrawn by compressing the finger grips at the back of the unit so that in the unlikely event of faulty operation a spare unit can be inserted with minimum interruption to production.

The switch can be arranged as a two-way changeover switch with or without spring return to "off"; a changeover switch without a central "off" position; or a changeover switch with spring return from top or bottom position only. This is achieved by a four-sided cam plate which can be positioned on site to provide the duty required. The switch is operated by a lever moulded in an unbreakable resilient material.

Radio Frequency Cable

Flexible solid-dielectric r.f. cables of normal construction show variations of phase constant during handling and flexing, and for certain applications these changes are great enough to be objectionable. The reason for the effect is that tightening or loosening of the braided outer conductor alters the proportion of air to solid insulation in the cable dielectric, and therefore changes the velocity of propagation. A new cable now marketed by the TELEGRAPH CONSTRUCTION & MAINTENANCE CO., LTD., Telcon Works, Greenwich, S.E.10, is designed to overcome this disadvantage and shows an improvement of about four times over conventional cable. The new cable is a modified UR 67 and is coded PT 93 MW.

Flameproof Limit Switch

A flameproof pattern of the B.S.A. Acme "Snap-Lock" switch has been designed to comply with the requirements of B.S.S. 229 and 587 and for some time a number of these switches have been used in collieries. The mechanism of the new switch is identical with that of the standard "Snap-Lock" design and they are available from BURTON, GRIFFITHS & CO., LTD., 93, Albert Embankment, London, S.E.11.

This flameproof switch is safe against Class II and III gases which include blast furnace gas, hydrocarbons encountered in the petroleum industry, liquids derived from coal tar, many industrial solvents such as cellulose solvents, coal or town's gas and coke oven gas, as well as Class I gases encountered in colliery work. The switch has received the Buxton certificate.

It is a single-phase, or d.c. double circuit, or two-way switch having one normally closed and one normally open circuit, which can be reversed by moving the return spring to the side required.

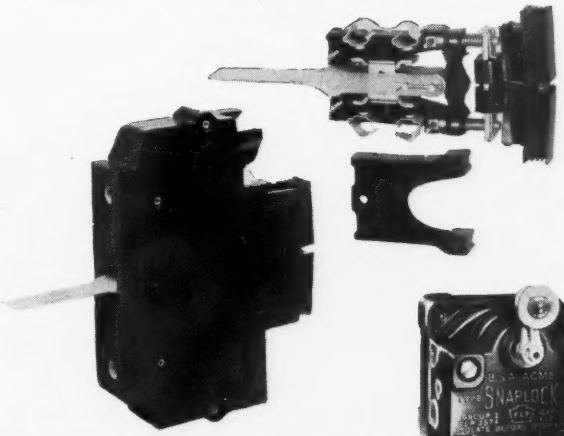
Instead of the usual separate flameproof terminal chamber a four-pin plug and socket has been introduced, the body of the plug forming the sealing chamber.

Roughness Tester

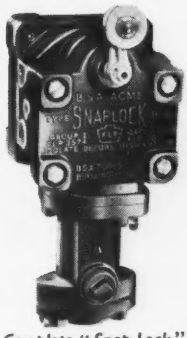
PHILIPS ELECTRICAL, LTD., Century House, Shaftesbury Avenue, London, W.C.2, announce that, because of new-type, precision-machined calibration standards, their PR.9151 roughness tester can now provide even more precise measurements of surface finish. The four comparative standards supplied are used for fixing the calibration points at 125, 32, 8, 2 micro-inches, respectively, and are, in every case, individually calibrated by "Talysurf" measurement. Generally, the maximum error on roughness tester readings is only ±10 per cent and this can be reduced by the operator with practice.

The roughness tester is a mains-driven, electronic instrument—portable enough to be taken into the workshop and so simple to use that it can be operated by the average machine hand after a short period of instruction.

The measuring pick-up is less than the size of a cigarette, so that it can be inserted into tubes with an internal bore of only $\frac{3}{8}$in. Its smallness also enables constant checks to be taken on even the most complicated components without removing the workpiece from the machine.

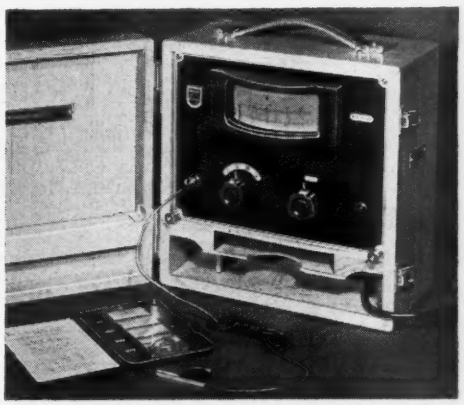


Left: Complete control switch and a view of one partly dismantled



Complete "Snap-Lock" flameproof limit switch

Below, right: Philips roughness tester and box of standards



NEW PATENTS

Electrical Specifications Recently Published

The numbers under which the specifications will be printed and abridged are given in parentheses. Copies of any specification (3s 0d each including postage) will be obtainable after 29th February from the Patent Office, 25, Southampton Buildings, London, W.C.2.

1950

29801. British Thomson-Houston Co., Ltd.—Electron discharge devices. 3rd March, 1952. (745421.)

1951

23340. Loewe Opta Akt.-Ges.—Electric discharge lamps. 8th October, 1951. (745423.)

27964. National Research Development Corporation.—Apparatus for electrically heating materials in a controlled atmosphere. 27th November, 1952. (745629.)

28665. General Electric Co., Ltd., and Robertshaw, R. G.—Magnetrons. 5th March, 1953. (745810.)

1952

1538. Fielding & Platt, Ltd.—Extrusion of multi-layer sheathing for electric cables. 8th July, 1953. (745726.)

11534. British Thomson-Houston Co., Ltd.—Control electric motors. 18th March, 1953. (745514.)

14319. Philips Electrical Industries, Ltd.—Ceramic insulating material. 6th June, 1952. (745515.)

17105. Electric & Musical Industries, Ltd.—Valve amplifiers. 1st July, 1953. (745429.)

18008. General Electric Co., Ltd., and Sherwen, J. W.—Electromagnetic vibrating equipment. 1st July, 1953. (745518.)

18341. Siemens Electric Lamps & Supplies, Ltd.—Fluorescent materials. 10th July, 1953. (745560.)

20188. Edison Swan Electric Co., Ltd.—Electronic apparatus including photo-electric multiplier cells. 21st May, 1953. (745521.)

20840. M-O Valve Co., Ltd., Kettlewell, E., Willshaw, W. E., Boot, H. A. H., and Buckingham, J.—Resonant cavity magnetrons. 18th November, 1953. (745729.)

21017. British Iron & Steel Research Association.—Electrical recording systems. 11th November, 1953. (745643.)

23799. British Insulated Callender's Cables, Ltd.—Presses for the extrusion of metal. 22nd September, 1953. (745731.)

24248. M-O Valve Co., Ltd., and Newton, R. H. C.—Travelling wave velocity modulated valves.—16th December, 1953. (745523.)

26864. Wild, E. G., and Wild, J. L.—Electrical heating systems and devices or appliances therefor. 26th January, 1954. (745735.)

29234. British Thomson-Houston Co., Ltd.—Electric discharge lamps. 19th November, 1952. (745736.)

31568. Clang, Ltd., Austen, H. E., and Harwood, C. D.—Electric fused socket adaptors. 12th March, 1954. (745739.)

1953

4515. English Electric Co., Ltd.—Three-phase electric transformers and laminated magnetic cores therefor. 12th February, 1954. (745534.)

4558. General Electric Co., Ltd.—Collecting devices for use with power presses. 4th February, 1954. (745535.)

4819. Hohner Akt.-Ges., M.—Method of distorting electrical vibrations and means for carrying the method into effect. 20th February, 1953. (745436.)

4983/4 and 5410. Short Bros. & Harland, Ltd.—Analogue computors for solving differential equations. 11th February, 1954. (745656/7 and 745660.)

5124. Garrett Corporation.—Thermostatic valve. 3rd March, 1952. (745659.)

5228. Siemens & Halske Akt.-Ges.—Frequency convertor units. 25th February, 1953. (745438.)

5364. Crabtree & Co., Ltd., J. A., and Wintle, T. D. G.—Electric switches or circuit-breakers. 1st February, 1954. (745744.)

6180. General Electric Co., Ltd., and Beesley, J. H.—Electrical gas discharge tube circuits. 28th April, 1954. (745538.)

6190. National Research Development Corporation.—Crash operated electric switch devices. 5th May, 1954. (745539.)

7393/4. De Havilland Propellers, Ltd., and Perdue, R. J.—Anemo electric power plants. 12th March, 1954. (745663/4.)

7485. Philips Electrical Industries, Ltd.—Sources of ions. 18th March, 1953. (745441.)

11749. Wolf Electric Tools, Ltd.—Portable electric tools. 14th April, 1954. (745544.)

12953. Edison Swan Electric Co., Ltd.—Electric lanterns. 10th May, 1954. (745447.)

13247. Quasi-Arc Co., Ltd.—Electrode holders for arc welding. 1st June, 1954. (745448.)

13473. Egen Electric, Ltd., and Collins, K. E.—Devices for effecting adjustment of magnetic cores in inductance coils. 13th May, 1954. (745549.)

13890. Igranic Electric Co., Ltd.—Method and system for generating polyphase alternating current. 18th May, 1953. (745748.)

16830. Babcock & Wilcox, Ltd.—Apparatus for cleaning the surfaces of heat exchange means. 18th June, 1954. (745556.)

19785. Metropolitan-Vickers Electrical Co., Ltd.—Electrical timing apparatus. 16th July, 1954. (745563.)

20521. Ferguson Pailin, Ltd.—Air-break electric switches or circuit-breakers. 25th June, 1954. (745755.)

21485. General Electric Co., Ltd.—Methods of manufacturing wire wound resistance or inductance elements. 18th August, 1954. (745567.)

23062. Williams, B. C. Fleming.—Radar indicating arrangements. 9th August, 1954. (745571.)

23162. Siemens Electric Lamps & Supplies, Ltd.—Manufacture of fluorescent materials. 20th August, 1954. (745572.)

23422. Aircraft-Marine Products, Inc.—Tools for crimping electrical connectors. 25th August, 1953. (745691.)

23585. Telefunken Ges.—High frequency thermionic valve generator systems. 26th August, 1953. (745574.)

24047. Sunbeam Corporation.—Electric mixer. 31st August, 1953. (745575.)

24446. Hammes, E. J.—Electric motor and centrifugally-operated reversing switch for a garbage disposal unit. 4th September, 1953. (745469.)

24536. Standard Telephones & Cables, Ltd.—Noise killer for frequency modulated radio receivers. 4th September, 1953. (745471.)

24836. Bendix Aviation Corporation.—Dynamo-electric machine control system. 8th September, 1953. (745695.)

25569. Illsley, S. A.—Device for indicating the level of the electrolyte in electric storage batteries. 19th May, 1954. (745581.)

26446. Standard Telephones & Cables, Ltd.—Methods of producing silicon of high purity. 17th September, 1954. (745698.)

27713. Metropolitan-Vickers Electrical Co., Ltd.—Electrical drying processes and apparatus. 25th August, 1954. (745700.)

27984. Dole Valve Co.—Thermostatic valve. 12th October, 1953. (745481.)

28200. Gretener, E.—Carbon electrodes for high intensity arc lamps. 13th October, 1953. (745586.)

28235. Compagnie Générale de Télégraphie sans Fil.—Production of sealed envelopes for electronic tubes and like devices. 13th October, 1953. (745587.)

28533. Radio Corporation of America.—Semi-conductor system. 15th October, 1953. (745483.)

29122. Wayne Kerr Laboratories, Ltd., Cullen, A. L., and Rogal, B.—Coupling circuits for coupling between a waveguide and a transmission line. 21st October, 1954. (745701.)

30857. Soc. Anon. de Machines Electrostatiques.—Electrostatic generator. 6th November, 1953. (745489.)

31318. British Telecommunications Research, Ltd.—Electric signalling apparatus. 11th October, 1954. (745491.)

31565. Midland Silicones, Ltd., formerly Dow Corning, Ltd.—Silicone resins. 13th November, 1953. (745706.)

32966. National Research Development Corporation.—Electromagnetic devices for producing mechanical displacements. 15th November, 1954. (745496.)

33278. Compagnie Générale de Télégraphie sans Fil.—Radio direction finders. 30th November, 1953. (745498.)

34304. Trion Akt.-Ges.—Electrostatic filters. 9th December, 1953. (745609.)

34429. Licentia Patent-Verwaltungs-Ges.—Device for stabilizing the voltage of a synchronous electricity generator. 10th December, 1953. (745770.)

34869. Lucas (Industries), Ltd., J.—Centrifugally operated electric switches. 7th December, 1954. (745611.)

34964. Philips Electrical Industries, Ltd. (Naamlooze Vennootschap Philips' Gloeilampenfabrieken).—Frequency discriminator circuits for ultra high frequency oscillations. 15th December, 1953. (745612.)

36034. Haldex Aktiebolag.—Device for actuating electrically operated counting mechanisms, particularly in taximeters. 29th December, 1953. (745507.)

1954

1214. Erie Resistor Corporation.—Method of making printed circuits. 15th January, 1954. (745773.)

2322. Standard Telephones & Cables, Ltd.—Manufacture of electrical capacitors. 26th January, 1954. (745775.)

3090. Shawinigan Chemicals, Ltd.—Flexible cables for electric furnaces. 13th May, 1954. (745779.)

3441. Western Electric Co., Inc.—Equalizer adjusting circuit. 5th February, 1954. (745716.)

3566. General Motors Corporation.—Drip pans for electric cooker-range heater elements. 8th February, 1954. (745781.)

3937. Soc. d'Appareils de Controle et d'Equipement des Moteurs.—Rotating electrostatic machines producing a periodical discharge. 10th February, 1954. (745783.)

16057. Fernseh Ges.—Electromagnetic deflection systems for electron beams. 31st May, 1954. (745718.)

17427. Akt.-Ges. für Technische Studien.—Double-walled hollow structure for the reception of highly heated media under pressure for thermal power plants. 14th June, 1954. (745795.)

17937. Standard Telephones & Cables, Ltd.—D.c. voltage regulators. 18th June, 1954. (745796.)

28608. Allmanna Svenska Elektriska Aktiebolaget.—Electromagnetic pump. 5th October, 1954. (745807.)

NEXT WEEK'S EVENTS

Organizers of electrical functions are advised to make use of the "Electrical Review" clearing house, Room 221, Dorset House, Stamford Street, London, S.E.1, to ascertain that proposed dates for their functions do not clash with others already arranged.

Monday, 30th January

LEEDS.—The University, 7.30 p.m. Incorporated Plant Engineers, West and East Yorkshire Branch. "An Introduction to Atomic Energy," by J. A. Dixon.

MANCHESTER. — Engineers' Club, Albert Square, 5.45 p.m. E.I.B.A. Manchester & District Branch. Annual general meeting.

SOUTHAMPTON. — A.S.E.E. Southampton Branch. Visit to Fire Brigade Headquarters.

Tuesday, 31st January

CAMBRIDGE.—Technical College, Collier Road, 6.30 p.m. I.E.E. East Anglian Sub-Centre. "Germanium and Silicon Power Rectifiers," by T. H. Kinman, G. A. Carrick, R. G. Hibberd and A. J. Blundell.

COVENTRY.—Methodist Central Hall, Warwick Lane, 7 p.m. I.E.E. South Midland Graduates' & Students' Section. "Quality Control," by N. R. Bedford.

Technical College, 7.15 p.m. A.S.E.E. Coventry Branch. "Fluorescent Applications," by J. D. Layton.

EDINBURGH.—Carlton Hotel, North Bridge, 7 p.m. I.E.E. South-East Scotland Sub-Centre. "Colour Television," by Dr. G. N. Patchett.

LONDON.—Savoy Place, W.C.2, 5.30 p.m. I.E.E. Measurement & Control Section. Discussion on "The Design and Use of Electrical Measuring Instruments for Arduous Conditions of Service," opened by C. A. Oldham and G. N. Harding.

At the Institution of Civil Engineers, Great George Street, S.W.1, 5.30 p.m. Institution of Electrical Engineers. "The Pimlico District Heating Undertaking—Costs and Financial Results," by B. Donkin, C. M. Johnston and E. Ockenden. (Joint meeting with the Institution of Civil Engineers.)

At the Institution of Electrical Engineers, Savoy Place, W.C.2, 6 p.m. Electrical Association for Women. Caroline Haslett Lecture: "Electricity in the Low Countries: The Women in the Industry," by Miss M. S. Mitchell.

LUTON.—At Messrs. S.K.F., Ltd., 7.30 p.m. Institution of Production Engineers, South Eastern Region, Luton Section. "Electronic Computers."

MANCHESTER. — Engineers' Club, Albert Square, 6.15 p.m. I.E.E. North-Western Centre. "Intensification of the X-Ray Image in Industrial Radiology," by Dr. A. Nemet and W. F. Cox.

WIMBLEDON.—32, Worple Road, 8.15 p.m. A.S.E.E. South-West London Branch. Introduction of prospective members.

Tuesday, 31st January, to Friday, 3rd February

LONDON.—Electrical Housecraft Advisers' Conference at Victoria Halls, W.C.1, Olympia, and the Connaught Rooms, W.C.2.

Wednesday, 1st February

BIRMINGHAM.—James Watt Institute, Great Charles Street, 7 p.m. Junior Institution of Engineers, Midland Section. Section Presidential Address, by O. D. Smith.

DAGENHAM.—I.E.E. London Graduates' & Students' Section. Visit to Ford Motor Co., Ltd., at 2 p.m.

GLASGOW.—39, Elmbank Crescent, 7 p.m. I.E.E. South-West Scotland Sub-Centre. "Colour Television," by Dr. G. N. Patchett.

HARRINGAY.—Queen's Head, 677, Green Lanes, 7.45 p.m. A.S.E.E. North London Branch. "Spot Welding," by C. G. F. Aldridge.

LIVERPOOL.—1, Old Hall Street, 7 p.m. British Institution of Radio Engineers, Merseyside Section. "Development of a Design for an Angle Modulation Radio Link," by H. C. Spencer.

LONDON.—At the Institution of Electrical Engineers, Savoy Place, 5 p.m. Institution of Post Office Electrical Engineers, London Centre. "Civil Engineering Aspects of Radio Stations' Work," by L. L. Hall and S. G. Young.

At the Institution of Civil Engineers, Great George Street, S.W.1, 5.30 p.m. Institute of Fuel. "The Harnessing of Nuclear Power for Industry," by J. L. Gillams.

MANCHESTER. — Engineers' Club, Albert Square, 7.30 p.m. A.S.E.E. Manchester Branch. "Lightning Conductors."

NEWCASTLE-UPON-TYNE. — King's College, College Road, 6.15 p.m. I.E.S. Newcastle Centre. "Use of Light in Horticulture," by D. H. Holloway.

PORTSMOUTH.—College of Technology Extension, Anglesea Road, 6.30 p.m. I.E.E. Southern Centre. "Problems of Hydro-Electric Design in Mixed Thermal-Hydro-Electric Systems," by T. G. N. Haldane and P. L. Blackstone.

PRESTON. — 49a, Fishergate, 7.30 p.m. A.S.E.E. Preston Branch. "High Frequency Heating in Industry," by R. Northmore.

RUGBY.—College of Technology & Arts, 6.30 p.m. I.E.E. Rugby Sub-Centre. "Germanium and Silicon Power Rectifiers," by T. H. Kinman, G. A. Carrick, R. G. Hibberd and A. J. Blundell.

SWANSEA.—S. Wales Electricity Board's Demonstration Theatre, The Kingsway, 6.30 p.m. I.E.S. Swansea Group. "Black Light, its Effect and Applications," by H. L. Privett.

Thursday, 2nd February

CARDIFF. — S. Wales Electricity Board's Demonstration Theatre, The Hayes, 5.45 p.m. I.E.S. Cardiff Centre. "Black Light, its Effect and Applications," by H. L. Privett.

CHELMSFORD. — Hoffmann's Social Hall, 7.30 p.m. Chelmsford Engineering Society. "The Unit System of Natural Ventilation," by L. Gordon Davies.

CROYDON.—Half Moon Hotel, Broad Green, 8 p.m. A.S.E.E. South London Branch. "Atomic Energy," by Dr. Hugh.

EDINBURGH. — Charlotte Rooms, 8 p.m. I.E.E. South-East Scotland Sub-Centre. Joint dance with the Institution of Civil Engineers.

LONDON.—Savoy Place, W.C.2, 5.30 p.m. Institution of Electrical Engineers, ordinary meeting. "The Potentialities of Railway Electrification at the Standard Frequency," by E. L. E. Wheatcroft and H. H. C. Barton. (Utilization Section paper.)

Hope House, 45, Great Peter Street, 7 p.m. Women's Engineering Society, London Branch. "Aspects of Railway Engineering Works," by Miss H. L. Bussell.

MANCHESTER. — College of Technology, Sackville Street, 6.30 p.m. British Institution of Radio Engineers, North-Western Section. "Design of Battery Operated Frequency Modulation Receivers," by R. A. Lampitt.

NOTTINGHAM.—E.M.E.B., Smithy Row, 6 p.m. I.E.S. Nottingham Centre. "The History of Mine Lamps," by Miss H. M. Maurice.

Friday, 3rd February

BIRMINGHAM.—Grand Hotel, 6.30 p.m. I.E.E. South Midland Centre. Annual dinner.

LIVERPOOL.—9, The Temple, 24, Dale Street, 7.30 p.m. A.S.E.E. Liverpool Branch. "Instrument Transducers and their Application to Industry," by G. R. Polgreen.

MANCHESTER.—Embassy Suite (Locarno), Washway Road, Sale, 7.30 p.m. I.E.E. North-Western Utilization Group. Dinner-dance.

NEWCASTLE-UPON-TYNE. — Liberal Club, 7 p.m. I.E.E. North-Eastern Centre. "The Recent Search for and Salvage of the Comet Aircraft near Elba," by Commander C. G. Forsberg and G. G. MacNeice and "The Tyne Tunnel," by J. Kell.

Saturday, 4th February

BIRMINGHAM.—At the Midlands Institute, 2.30 p.m. Institution of Chemical Engineers, Midlands Branch. Annual general meeting, followed at 3 p.m. by "Practical Aspects of Electrostatic Precipitator Operation—Experiments on Pilot Plant," by A. Little.

LANGLEY.—I.E.E. London Graduates' & Students' Section. Visit to Road Research Laboratory, D.S.I.R. (Traffic & Safety Division), at 10 a.m.

LONDON.—A.S.E.E. South-West London Branch. Morning visit to the National Physical Laboratories.

CATALOGUES AND LISTS

ACCESSORIES.—Price list (27) of the company's range of electrical wiring equipment.—**Nettle Accessories, Ltd.**, Harper Road, Wythenshawe, Manchester.

67-page priced and illustrated catalogue covering the company's full range of electrical accessories.—**Edison Swan Electric Co., Ltd.**, 155, Charing Cross Road, London, W.C.2.

AIR COOLING.—28-page illustrated descriptive brochure dealing with the principles of specialized air cooling by axial flow blowers.—**Plannair, Ltd.**, Leatherhead, Surrey.

CONTROL INSTRUMENTS. — Loose leaf catalogue giving particulars of the "Servomex" range of voltage stabilizers and motor speed controllers, etc.—**Servomex Controls, Ltd.**, Crowborough Hill, Jarvis Brook, Sussex.

EARTHING EQUIPMENT.—Priced descriptive brochure on the "Portaway" earth-continuity and bonding system.—**Porter Electrical Products, Ltd.**, 2, North Park Road, Harrogate, Yorks.

EDUCATIONAL EQUIPMENT.—15-page pamphlet showing the use of the company's electrical equipment and instruments in technical educational establishments.—**Crompton Parkinson, Ltd.**, Crompton House, Aldwych, London, W.C.2.

FURNACES.—Three leaflets describing low frequency induction melting furnaces for cast iron, copper alloys and light alloys respectively.—**G.W.B. Furnaces, Ltd.**, Dibdale Works, Dudley, Worcs.

INSTRUMENTS.—Leaflet (L125) describing the B.R.S. daylight factor meter.—**Evans Electroselenium, Ltd.**, Harlow, Essex.

LIGHTING FITTINGS.—Illustrated 36-page catalogue giving particulars of hand-made lighting fittings in wrought iron and brass.—**Stephen Glover & Co.**, Intown, Walsall.

MOTORS.—Illustrated brochure (ML.82) on the company's range of flameproof motors, together with a leaflet (ML.82A) giving particulars of the report by the Buxton testing station on one of these machines.—**Lancashire Dynamo & Crypto, Ltd.**, St. Stephen's House, Victoria Embankment, London, S.W.1.

PROCESS TIMER.—A leaflet (170) describing the type RFT synchronous process timer.—**Londex, Ltd.**, Anerley Works, 207, Anerley Road, London, S.E.20.

SIGNAL LAMPS.—Leaflet (142/A) describing a range of single-hole fixing signal lamp fittings for S.E.S. lamps.—**Londex, Ltd.**, Anerley Works, 207, Anerley Road, London, S.E.20.

CONTRACT INFORMATION

Accepted Tenders and Prospective Electrical Work

CONTRACTS OPEN

Where "Contracts Open" are advertised in our "Official Notices" section the date of the issue is given in parentheses.

Formosa.—5th March. Central Trust of China, Taipei. Impulse turbine for hydro-electric power station. (E.S.B. 622/56/ICA. Ten/17524.)* 7th February. Three electrically-driven centrifugal pumps. (E.S.B. 623/56/ICA. Ten/17523.)*

Greece.—6th February. Office of State Procurements Service, Athens. Lead storage batteries. (E.S.B. 987/56. Ten/17533.)*

Iraq.—15th February. Directorate General of Municipalities. Two 100 kW and one 50 kW diesel engine driven alternator sets. (E.S.B. 1322/56. Ten/17595.)*

Ormskirk.—11th February. West Lancashire R.D.C. Street lighting equipment. (See this issue.)

Pakistan.—15th February. Engineering Department, Karachi Port Trust. Fork lift trucks and battery platform trucks and equipment. (E.S.B. 1410/56. Ten/17594.)*

Truro.—4th February. County Council. Electrical services in connection with the erection of a new county secondary school, Looe, and a new infants' school, Liskeard. (See this issue.)

Warrington.—6th February. R.D.C. Laying of 1,200 yd of trunk road lighting cable. (See this issue.)

WORK IN PROSPECT

Particulars of new works and building schemes for the use of electrical installation contractors and traders. Publication in this section is no guarantee that electrical work is definitely included. Alleged inaccuracies should be reported to the Editors.

Aldershot.—Flats (92), North Town area; borough surveyor.

Altrincham.—College of Further Education for Cheshire C.C.; C. Cornes & Sons (Cheshire), Ltd., Winsford, Cheshire.

Angmering.—Large factory (£70,000), for Crawley Metal Productions, Ltd., 27, Ifield Road, Crawley; C. W. Wolledge, architect, 6, Goring Road, Worthing.

Ashington (Northumberland).—Additions to Ashington Hospital for Newcastle Hospital Board, Benfield Road, Newcastle-on-Tyne (£127,000); P. H. Knighton, Board's chief architect.

Aveley.—Works for Ford Motor Co.; E. R. Collister & Associates, architects, Springfield Place, Chelmsford.

Belfast.—Large block of shops and offices in Donegall Place; Donald Hamilton, Wakeford & Partners, architects, 7, Connaught Place, Paddington, London, W.2.

Berwick-on-Tweed.—Two welfare centres (£20,000); county architect, County Hall, Newcastle.

Blackpool.—Houses (139) and flats (12), at Grange Park Estate, for T.C.; Middleton & Co. (Blackpool), Ltd., Bank Street Sidings.

Bradford.—Block of shops and offices at Market Street; Clyde Young & Bernard Engle, architects, 8, New Square, Lincolns Inn, London, W.C.2.

Bury St. Edmunds.—Additional nurses' accommodation, Suffolk General Hospital; J. Stinton Jones & Partners, consulting engineers, 21, Gloucester Place, W.1.

Carlisle.—Additions to Art Buildings (£75,000); city engineer, 18, Fisher Street.

Chesterfield.—Three-classroom unit at Manor School; Wilcockson & Cutts, architects, 12, Saltergate, Chesterfield.

Chingford.—Erection of new teaching block at County High School (£25,000); H. Conolly, county architect, County Hall, Chelmsford.

Croydon.—Houses (165), on sites at Lodge Lane, Kingsdown Avenue and Ashburton; E. Taberner, town clerk, Town Hall, Katharine Street.

Dorking.—Office block for Friends Provident & Century Life Office; John Laing & Son, Ltd., builders, Bunns Lane, N.W.7.

Douglas (Isle of Man).—Chest clinic for Noble's Hospital; W. T. Quayle, architect, 29, Athol Street.

Dover.—Coach Hotel, Camden Crescent; Louis Erdi, architect, 27, Knightrider Street, London, E.C.4.

Durham.—Junior county school at Billingham (£52,000); A. V. Clerey and Son, builders, Frederick Street, Sunderland.

Ealing.—Two halls, Greenford (£120,000); C. W. Seddon, borough surveyor, Town Hall, London, W.5.

Felling (Co. Durham).—Development scheme at Wardley No. 2 and 3 pits, including general offices, canteen, medical centre, pithead baths and lamp cabin; N.C.B. Architects' Dept., Ashfield Towers, Gosforth, Northumberland.

Fletton.—Police station (£52,000), for Hunts. Standing Joint Committee; county architect, County Buildings, Huntingdon.

Foots Cray.—Central depot (£127,000), for Chislehurst & Sidcup U.D.C.; W. B. Farrow, surveyor, Manor House, Sidcup, Kent.

Gateshead.—Children's Home at Lobley Hill; borough surveyor.

Large extensions to factories of Huwood & Co., Ltd.; L. J. Couves & Partners, Carliol House, Newcastle.

Branch library at Wrekenton for the T.C. (£16,000); Graham and Son, builders, Haslam House, West Croft Road, Newcastle-on-Tyne, 12.

Glasgow.—Experimental research station; Yarrow & Co., Ltd., South Street.

Offices, London Road, Bridgeton; W. & J. R. Watson, Ltd., 81, Great King Street, Edinburgh.

Harlow.—Shops and offices, New Town central area; Donald Hamilton, Wakeford & Partners, architects, 7, Connaught Place, London, W.2.

Hartlepool.—Major extensions at Palmers Works (£2,000,000); Steetley Magnesite Co., Ltd., Palliser Works.

Heywood.—Extensions to Municipal Buildings (£40,000); borough surveyor, Municipal Buildings, Longford Street.

Hyde.—Works and offices at Junction Street, for T. Brown & Co., Ltd.; J. Rose, architect, 14, Cross Street, Hyde, Ches.

Jarrow.—Central fire station; county architect, Durham.

Leatherhead.—Shops and offices, High Street; Ravenseft Properties, Ltd., 52, Charles Street, London, W.1.

Liverpool.—Development of Newchurch Hospital for Regional Hospital Board; T. Mitchell, architect to the Board, 88, Church Street.

Fire station at Conleach Road and North Parade, Speke, for T.C.; J. B. Johnson & Co., Ltd., 17, Overton Street.

London.—Office block, Portpool Lane, Holborn; Seifert & Seifert, architects, 28, Great Ormond Street, W.C.1.

R.C. school for girls, St. Charles' Square, North Kensington; Nicholas & Dixon Spain, architects, 19, Hanover Square, W.1.

Showrooms and offices, Howland Street and Whitfield Street, Westminster; Windsmoor (London), Ltd., 174, Old Street, E.C.1.

Morpeth.—Outpatients' department at Morpeth Cottage Hospital for Newcastle Hospital Board, Benfield Road, Newcastle-on-Tyne (£28,000); P. H. Knighton, chief architect.

New Barnet.—Shops (9) and maisonnettes, Mount Pleasant Roundabout and three-storey block of flats at Fordham Road; U.D.C. surveyor, Town Hall, Station Road.

Newcastle-on-Tyne.—Flats and maisonnettes (126), near Hodgkin Park, for the City Council; city architect, 18, Cloth Market.

Block of offices, Hood St.; L. J. Couves & Partners, Carliol House.

Oxford.—Shops and flats, The Oval; city architect.

Richmond (Yorks).—Home for aged and disabled persons, Hill House estate (£49,350); county architect, County Hall, Northallerton.

Scarborough.—Flats (105); H. V. Overfield, borough engineer.

Shrewsbury.—R.C. church at Ditherington estate; H. Price & Son, Welsh Bridge, Shrewsbury.

Southall.—Proposed town hall, including administrative block, assembly hall, council suite, etc.; J. R. Syrett, town clerk, South Road, Southall, Mdx.

Southend-on-Sea.—Science block for Westcliff Boys' High School; borough architect.

South Shields. — R.C. inter-parochial secondary school; Page, Son and Hill, architects, 75, King Street.

Proposed "Grey Hen" Hotel, Harton Lane, for Rowell and Sons; Page, Son and Hill, architects, 75, King Street.

Stockton-on-Tees.—County school in Stockton rural area; county architect, Durham.

Stourbridge.—Primary school at Pedmore Fields, for County E.C.; Yorks, Rosenberg & Mardall, architects, 2, Hyde Park Place, London, W.2.

Sunderland.—R.C. church, Hykton Road, Pennywell; Matkin and Hawkins, architects, Barclays Bank Chambers, Fawcett Street, Sunderland.

Rebuilding "Empress Hotel," Union Street for J. Deuchar, Ltd., Newcastle-on-Tyne (£75,000); E. M. Lawson, architect, Barras Buildings, Newcastle-on-Tyne.

Taunton.—Extensions to County Hall (£225,000), for Somerset C.C.; R. O. Harris, county architect, Park Street, Taunton.

Tipton.—Dwellings (144), Princes End site; borough surveyor.

Upavon.—Primary school; F. Rendell & Sons, Ltd., builders, St. John Street, Devizes.

Wakefield.—New shop premises for Montague Burton, Ltd., at Kirkgate; Nicholson, Harlow & Co., Ltd., Lawefield Lane, Wakefield.

Wallsend.—Houses (60), Low Willington Farm estate, and 18 near Mullen Road; G. N. Teasdale, borough engineer.

Walsall.—Houses (196), at Mossley estate, for B.C.; Sir Alfred McAlpine & Son, Ltd., 49, Waterloo Road, Wolverhampton.

West Riding.—Swinton Secondary Modern School for C.C.; Wade Construction Co., Ltd., High Street, Wath-on-Dearn.

Whitley Bay.—Houses (41), near Seatonville Road, Monkseaton; L. G. Wood, architect, 17, Northumberland Square, North Shields.

Winchester.—Eighty flats and maisonnettes, Weeke estate; A. S. Wilson & Partners, surveyors, 8, Storey's Gate, London, S.W.1.

Wisbech.—Factory extensions; The Metal Box Co., Ltd., The Langham, Portland Place, London, W.1.

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* Specifications may be inspected at the Export Services Branch, Board of Trade, Lacon House, Theobald's Road, London, W.C.1 (Chancery 4411; extension 769).